TRANSITIONS IN THE MEXICAN SUGAR INDUSTRY

By

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by

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TRANSITIONS IN THE MEXICAN SUGAR INDUSTRY

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This study examines the many and varied structural changes that are occurring within the Mexican sugar industry, with special attention give to the period from 1988 through 1997. During this period, the industry experienced the privatization of sugar mills, the liberation of the domestic sugar price, a move toward basing the payment for sugarcane on sucrose content as opposed to the weight of the cane and trade liberalization through the signing of the North American Free Trade Agreement (NAFTA). The study includes two basic sections. Part I includes a description of the status and a preliminary assessment of the many structure changes in the industry. Part II contains an econometric analysis of the price sensitivity of production, both at the national level and in the state of Veracruz. A theoretical framework is developed to analyze whether or not there exists an optimal price for domestic sugar, and if so, under which circumstances that optimal price would facilitate the

maintenance of a surplus quantity of sugar sufficient to gain access to the U.S. market in accordance with the side agreement for sugar in the NAFTA.

The results from Part I suggest that amid the many changes in the industry certain elements of the traditional system remain and these combine with the newer elements to create an industry that is more competitive and economically efficient yet not so different as to lose stability. Newer elements are the restructuring of medical and pension benefits, a market determined price for sugar and a reform of property rights for ejidal lands. More traditional elements of the industrial system include government support for the small growers, including financing and supervision of the system of payment for sugarcane.

The econometric analysis in Part II suggests that overall the national industry as well as the industry within the state of Veracruz, has become much more price-sensitive in the period since the sugar mills were privatized. The theoretical model suggests that under certain circumstances Mexico could continue to export to the world market in a way that will be beneficial to producers. This would depend on the ability of Mexico to support its sugar price at a level above the free-market closed-economy equilibrium, which is not necessarily possible. Continued increases in production are anticipated as a result of technological innovations, improved varieties and improved harvesting strategies.

CHAPTER 1
INTRODUCTION

Plagued by [illegible] debt obsolete equipment and inefficiency Mexico [illegible] industry has been on a losing streak for decades The industry s fortunes did not turn around when the government starting in 1988 began to privatize the 64 sugar mills it owned

Although the sale which lasted until 1993 put some $600 million in government coffers the sugar mills continue to report multimillion dollar losses and falling production As a whole the industry faces a severe financial crisis During 1993 the country s sugar mills lost a total of $300 million according to the National Sugar and Alcohol Industry Council Sugar production fell to 3 6 million tons or 13% during the 1993/94 harvest down from 4 1 million tons during the 1992/93 season

(*El Financiero* 1994 p 19)

Mexico has been exporting sugar literally for centuries and the industry is steeped in the history of the country—the Spanish sugar *haciendas* for example were some of the first targets for land reform in the early days of the Mexican revolution (Parkes 1970) More recently the industry survived the economic crisis of the early 1980s with the help of the federal government and it is currently challenged with the transition into a competitive private industry However in spite of increased monetary pressures and a climate of economic uncertainty brought about by reform policies Mexico s sugar industry has produced three consecutive record breaking harvests. Surplus sugar has been exported to the world market for two consecutive years since the *El Financiero* comments were published even though financial difficulties at the mills intensified in the wake of the economic crisis stimulated by the peso devaluation of December 1994

While improvements in productivity may have helped ameliorate fiscal challenges policy changes—such as the liberalization of the price of sugar and changes in the provision of social security for growers—may be aggravating an already precarious industry. Further uncertainty about the future of the Mexican sugar industry centers on the North American Free Trade Agreement (NAFTA) which, in a side agreement on sugar, will provide the Mexican sugar industry with increased access to the U.S. sugar market if and only if Mexico can maintain the status of "net surplus producer." Access to the U.S. market is desirable to the Mexican industry because the United States supports the price of sugar at approximately twice its price in the world market.

Though Mexico achieved "net surplus producer" status during fiscal years 1995/96 and 1996/97, its status is now threatened by the increasing substitution of imported U.S. high fructose corn syrup (HFCS) for Mexican domestic sugar. This threatens the achievement of its status because, in the NAFTA side agreement on sugar, "net surplus producer" is achieved only if the quantity of sugar produced in a given year is greater than the combined quantity of sugar and HFCS consumed (Garcia-Chavez 1998). The increased use of HFCS in Mexico is also related to NAFTA because the agreement calls for annual decreases in the Mexican tariff on imported U.S. HFCS. This tariff, which was formerly set at 13%, will decline annually by 1.5 percentage points to zero by the year 2002.

A better understanding of the sources of recent increases in sugar production will help assess the ability of the Mexican industry to meet future domestic needs and to export sugar. For example, though some credit for the record harvests of the past three years is attributable to favorable rainfall, some credit is undoubtedly due to improved factors such as

advancements in technology both in field and factory and institutional reforms that have led to improved pricing structures and decreased market interventions (Garcia Chavez 1996)

This study addresses the sugar industry in the state of Veracruz, Mexico by describing the current status of the industry It also takes into consideration the likelihood and implications of continued increases in production in the state as well as the attendant possible impacts of such increases on the larger North American sweetener market. The study will include a descriptive multiscale economic analysis of the Mexican industry with a focus on the state of Veracruz The remainder of this chapter provides an overview of the study including the background statement of the problem researchable questions objectives and organization of the study

Background

The Mexican sugar industry produced 4 66 million metric tons (MMT) of sugar in the harvest year 1995/96 ranking it seventh among the sugar producing nations of the world (USDA 1996) India and Brazil are by far the largest sugar producing nations followed by China, the United States, Thailand, Australia and Mexico France Cuba and Germany follow closely behind Mexico. An in depth comparison of the top sugarcane industries by country is revealing (Table 1 1) For example the average yield of cane per hectare in Mexico was 78 tons in 1995/96, the third highest of the top ten producers though still far below Australia s 98 metric ton yield or Colombia s 132 metric ton yield Similarly while Mexico s factory recovery rate (the amount of sucrose recovered as a percent of a ton of sugarcane)—along with its overall sugar yield per hectare—is improving, it is clear that more

improvement is possible It is also true that most of the other sugarcane producing countries have continued to improve their productivity measures through time

Sugar consumption in Mexico is also high ranking it sixth overall in the world with a per capita rate of 41 6 kg (91 5 lbs) per year (Tables 1 2 and 1 3) Overall consumption is considered a factor of population per capita consumption and income or GDP per capita Per capita consumption in the United States is less, at 30 1 kg (66.2 lbs) but people in the United States are also consuming an almost equivalent amount of other types of sweeteners while Mexicans primarily consume sugar Mexican per capita consumption has decreased slightly since the 1990/91 fiscal year from 45 8 kg per year to 41 6 kg per year This type of consumption pattern is not unusual many countries display similar fluctuations in consumption patterns through time

Table 1 1 Measures of Sugarcane Productivity in Selected Countries

Country	Area (1 000 ha)			Cane Yield (MT/ha)			Recovery Rate (%)			Sugar Yield (MT/ha)		
	6/85	1/90	6/95	6/85	1/90	6/95	6/85	1/90	6/95	6/85	1/90	6/95
Australia	304	339	383	80	74	98	13 9	14.3	13 7	11 2	10 6	13 4
Brazil	1700	1117	1950	51	64	61	9 5	10.5	11 4	4 9	6 8	7 0
Colombia	101	115	131	115	123	132	10 5	11 3	11 6	12 1	13 9	15 3
China	965	1009	1025	53	57	64	9 0	9 1	8 5	4 8	5 2	5 4
Cuba	1330	1350	1300	51	50	35	10 8	10 1	10 0	5.5	5 7	3 4
India	1322	2070	2450	60	66	75	10 3	10 1	10 0	6 1	6 6	7 5
Mexico	**543**	**525**	**540**	**74**	**69**	**7 8**	**9 7**	**10 8**	**11.0**	**7.2**	**7 4**	**8.6**
Pakistan	348	555	525	35	41	53	10 0	9 0	9 5	3 5	3 7	5 0
Thailand	618	895	968	39	45	60	10 8	9 7	10 9	4 2	4 4	6 6
U S A	293	294	351	83	68	74	11.3	11 5	12 0	9 4	9 4	8 8

ha=hectare
Source USDA (1996)

Table 1.1 Countries With Highest Sugar Consumption

Country	Consumption 1996 (1,000 MT)	Per Capita Consumption, 1996 (kg)
India	15 090	14 8
United States	8 666	30 1
China	8 250	6 4
Brazil	8 100	45 8
Russian Federation	5 000	31 0
Mexico	**4,260**	**41 6**
Germany	3 035	33 4
Pakistan	2 990	21 6
Indonesia	2 900	13 1
Japan	2 525	18 5

Table 1 3 Per Capita Consumption for Selected Countries

Country	Consumption per capita, 90/1 (kg)	Consumption per capita, 93/4 (kg)	Consumption per capita, 95/6 (kg)
Cuba	69 8	56 9	59 7
Netherlands	54 2	50 1	52 5
Malaysia	38 9	42.5	51 0
Chile	34 6	37 2	46 2
Brazil	43 5	43.5	45 8
Australia	47 0	39 2	44 0
Jamaica	45 1	46 5	43 6
Mexico	**45 8**	**43 2**	**41 6**
Ukraine	52 0	43 0	40 7
Poland	38 8	39 1	39 9
United Kingdom	36 9	39 2	37 1
Argentina	28 2	36.1	36 4

Source for both Tables 1-2 and 1 3 USDA (1996)

Sugar Mills

There are 64 sugar mills in Mexico and 24 of them are located in the state of Veracruz. Many were originally owned by private owners who were forced to sell to the government in the 1970s when they became indebted to Financiera Nacional Azucarera (FINASA), the government agency that handled loans to the sugar industry (Singlemann 1995). Another government agency, Azucar, S.A. managed most of the mills as well as the price maintenance program and also bought and sold most of the sugar. Beginning in 1988 with the reform measures led by then President Salinas, most of the 50 government owned sugar mills were sold, three to producer unions and the rest to industrial groups, mostly soft-drink bottlers (Buzzanell and Lord 1995, Olvera, 1991).

As a result, the industry has attracted investment capital to help revitalize the sugar mills. For example, Tate and Lyle, a sweetener company from England, purchased 49% of the Saenz group, one of the five largest Mexican sugar groups. This move was particularly encouraging as the deal did not close until after the fall of the Mexican peso, a time when many foreign investors were trying to get out of Mexico. Alejandro Solorzano, then director general of Mexico's newly formed sugar exchange, partially credited Tate and Lyle's investment support with the 1994/95 bumper harvest reported at 4.2 MMT (*Reuter European Business Report*, 1995).

Still, many mills suffer from problems of old equipment, poor management and low quality raw material. Mill time is lost when machinery fails, and low-efficiency mills lose sucrose to bagasse (a woody by-product of the sugarcane milling process) and other by-products. A number of mills in the state of Veracruz have been cited as lacking in

productivity in both the field and in manufacturing (Garcia Chavez 1993). Other mills have been called too small to be economically efficient. Very recent trends in the country have shown, however, that both sucrose recovery and downtime in the mills have improved (Pinto-Mazal 1995).

Other mill related efficiency problems are related to the transportation system: poor harvesting techniques and lack of irrigation. Sugarcane is transported over poor winding and potholed roads in old, open topped trucks that must wait sometimes two to three days in line before their shipments are unloaded and processed. Other states in Mexico have been shifting to mechanized harvesting. This may not be appropriate for much of Veracruz since sloping land and other geographical obstacles exist. Yet, as other states adopt technologies that improve efficiency, the state of Veracruz needs to also improve productivity if it is to maintain its share of the national market. Only about 18% of sugarcane cropland employs irrigation in Veracruz. In these areas, average yields were 86 metric tons per hectare from 1989 through 1992 for irrigated land while average yields on temporal lands were only 70 metric tons per hectare for the same years (INEGI 1993).

Relationship Between Producers and Mills

It is argued that the problem with the raw material received in the mills is low-sucrose and high fiber content. Both factors of which lead to decreased efficiency in rendering raw sugar from sugarcane (Garcia-Chavez 1993). Productivity in the field is a complicated topic because it is related to the dynamic relationship between the cane growers and the mills. This relationship has been awkward since the Mexican revolution when the large sugar *haciendas* were split up and given to the workers (Parkes 1970). Since that time, largely through the

mills' parafinancial role in providing credit to growers, an interesting system of shared control has evolved.

Individual growers usually contract their crops to the mill, and the mill then debits the fertilizers and other inputs used against the returns from the growers' harvest. In recent years, many mills have had difficulty paying the growers their due (which comes several times a year) because of financial stresses related to the recent economic crises and because the growers must be paid for the cane before the sugar is sold. Failure to pay growers has then resulted in grower strikes, which result in costly downtime at the mills. Failure to pay also removes the incentive for growers to cultivate their crops carefully or to favor their sugar crop with valuable inputs, such as time and money for improvements.

Problem Statement

The signing of NAFTA presents an opportunity for the Mexican sugar industry to gain a significant portion of the lucrative U.S. sugar import market. In order to do this, the industry must increase output more rapidly than the country increases HFCS consumption. While the past few years have suggested that such advancements are possible, it is unclear whether the improvements can be sustained in such a way as to consistently achieve the status of net surplus producer.

Researchable Questions

If the Mexican sugar industry is able to meet domestic demand in future years and to outlace the HFCS substitution process, the industry will gain access to U.S. markets in accordance with NAFTA, exporting will be attractive and expanded production may continue in Veracruz. If not, Mexico may become a sweetener importer, and resources currently used

[illegible] sugar production may be [illegible] put to [illegible] other [illegible]

become idle socioeconomic problems

The following researchable questions will help direct the project

1. What role have the variety of structural changes in the industry—such as [illegible] privatization deregulation of the sugar market reform of social security the new system of payment for sugarcane and reform of the land tenure laws played in the improved production? How do all of these forces work together?

2. Is the primary cause of the recent record sugarcane harvests in Mexico a change in efficiency (production and milling) and not merely the result of random environmental occurrences such as ample, well timed rainfall?

3. What are the technological innovations responsible for the recent increases in yields in the state of Veracruz? What potential exists for these and other innovations to continue to improve yields?

4. Under what set of circumstances is Mexico most likely to achieve net surplus producer" status?

Objectives

Planners and investors in both Mexico and the United States need a better understanding of the productive potential of the Mexican sugar industry in order to support and direct policy toward the regional sweetener industry in the twenty-first century. The specific objectives of the research are as follows

1. Describe the variety of structural changes occurring in the sugarcane industry of Veracruz assessing which changes are likely to bring positive and which are likely to have negative impacts on overall production

2. Develop a way to understand how the industrial system works and how different components of the system affect each other

3. Examine the net effect of the structural changes by considering the overall price sensitivity of production in Mexico and in Veracruz during the past 30 years in particular

4 Identify the various technological developments in sugarcane production in Veracruz and quantify where possible the impacts on costs yields and employment These developments include green harvesting, automatic cane loaders and improved irrigation

5 Develop an analytical model of the Mexican sugar industry and use it to assess the potential ability of the national industry to meet domestic demand for sugar and sustain its status as a net surplus producer

To meet these objectives it will be necessary to use a rather broad approach in analyzing the issues facing the Mexican sugar industry some of which have been touched on in this introduction An effort has been made to consider the issues at the various levels of analysis, the global, North American Mexican national mill and, finally the grower level of analysis (Figure 1 1) A complete analysis of these issues at all levels is not the goal here. A "slice" of the issues from the global economic level down to the grower level is analyzed, and an attempt is made to connect some of the interactions between issues at one level with those at another

Organization of the Study

The research project is divided into two parts The first part includes a detailed description of sugar production in Mexico with descriptions of the many institutional changes occurring at various levels of analysis (Chapters 2 3 and 4) The industry system as a whole is covered in chapter 4 which highlights some of the mechanisms of interaction between components of the system Part 2 contains analyses of the industry as it begins to face international economic conditions Price elasticities are estimated for the state of Veracruz and for the nation during the period from 1981 through 1996 (Chapter 6) and a

Figure 1.1 Issues and Recent Changes Facing the Mexican Sugar Industry Organized at Various Analytical Levels

theoretical framework is then developed to elucidate some of the pricing dynamics that present themselves to the industry in the present context of freer trade (Chapter 7)

Methodology

A number of issues simultaneously face each level of analysis These issues are dynamic and are rapidly producing changes in Mexican sugar production For this reason the description is based on lengthy interviews with key individuals who work with the industry and within the institutions involved The interviews were conducted in hopes of capturing a representative "slice" of the ongoing institutional transformation The majority of interviews were conducted in 1996 and 1997 Some of the participating institutions were

1. USDA Specialty Crops Division—managing the U.S sugar program and reconciling new NAFTA legislation
2. Camara Nacional de Azucarera y Alcohol—organization of mill owners
3. FINASA—mill and grower government financing institution
4. FORMA—newly formed Mexican sugar exchange
5. COAAZUCAR (Comite da Agroindustria Azucarera)—monitors relations between growers and owners and ensures compliance with sugarcane law
6. IMSS (Institute of Social Seguridad)—provides medical and pension benefits for growers
7. Individual sugar mills and sugar producing consortiums
8. National research institutions
9. Grower unions
10. Mill worker unions
11. Ejidal management groups
12. District water management offices

Three mills in Veracruz returned confidential surveys with information about costs of production future plans and problems Individual interviews were conducted with sugarcane growers, mill owners, cane cutters transportation drivers laborers working in the sugar mill environs union leaders marketing personnel mill inspectors, mill field officers agricultural engineers hired laborers and university researchers

Summary

The changes in institutional structures within Mexico s sugar industry and the trade liberalization in the North American sweetener market that has occurred with NAFTA create a collection of economic forces at work on an industry with a history of government control and grower protection Recent improvement in overall production in the industry suggests that the market oriented institutional changes are beginning to bring about the expected result The implications of this trend—for producers in Veracruz, in Florida and throughout Latin America and the Caribbean—are addressed here

CHAPTER 2
THE MEXICAN SUGAR INDUSTRY STRUCTURE AND RESTRUCTURE IN AN INTERNATIONAL CONTEXT

The development of sugar as a commodity has historically followed an intricate path. Europeans originally demanded sugar and tropical producers responded with supply (Mintz 1985). Along with this history comes an interesting set of global economic relationships—from preferential agreements to trade embargoes to a high degree of protection—that keep virtually all nations supplied with sugar. As Mexico prepares to move from essentially a position of autarky (or very little trade) to that of a net exporter of sugar, the status of international sugar production, consumption and trade becomes increasingly relevant. A closer analysis of Mexico's competitive position in terms of prices and industry structure reveals that long run international competitiveness is a feasible possibility for Mexico.

Associated with the spirit of competitiveness, the trend toward freer trade is one of the most important international economic considerations today. This affects the sugar industry in terms of GATT, NAFTA and in terms of the export oriented development strategy that inspires Mexico's current policy framework (Otero 1994). The trade agreement commitments and likely Mexican policy moves do not suggest ongoing subsidies or government support to encourage the transition to the status of a net-exporting nation. At the same time, liberation does provide new opportunities for producers. These opportunities, however, are matched with opportunities for consumers, and in the case of sweeteners, the

primary challenge to the Mexican sugar market will be the alternative sweetener high fructose corn syrup (HFCS) These topics comprise the basic set of international issues facing the sugar industry in Mexico

The structure of the Mexican sugar industry has survived profound mutations along with the changing sociopolitical themes of the country To understand which elements of the newly restructured industry present greater and lesser challenges it is useful to consider the historical traditions of the industry current structural changes reactions to these changes within the industry and the vision of the future which motivates the current reform. This chapter is thus divided into three general sections The objective of the first section is to provide the context of the international sweetener market context within which Mexico s changes are occurring. The second and third sections cover some of the historical themes upon which the current industry depends and a more in depth consideration of the current restructuring process Finally some thoughts about future relationships at the national level are covered

International Sugar The State of Sweeteners

Approximately 72% of world sugar is consumed in the country in which it is produced (USDA 1996) Originally produced from sugarcane grown in tropical and subtropical regions of the world, sugar is now also produced from sugar beets which are grown in temperate zones At present, more than 90 countries produce at least some sugar and virtually all nations consume it The rest of the sugar is bought and sold in the world market with the help of sugar exchanges the largest of which is the New York sugar coffee and cocoa exchange (Folopolus and Alvarez 1987) Because domestic sugar industries (such as the ones in the United States the European Community and Japan) are often protected

world prices are frequently lower than domestic prices (Schmitz 1995) The recent history of world sugar prices, however reveals a volatility through the 1970s and 1980s that at times led to world prices which were higher than domestic prices (see Table 2 1) (Brown 1987) Except for a brief price rise in early 1995 world raw sugar prices remained between 11 cents per pound and 13 cents per pound from mid 1993 to mid 1996 Refined sugar prices have varied more widely in the past few years with a high price of 20 27 cents per pound reported in July 1994 and a low of 11 6 cents per pound reported in January 1993

Mexico in the International Context Production

As of the 1995/96 harvest season Mexico was the seventh largest sugar producing nation in the world (Table 2-2) Record crops were reported in the major producing nations of India, Thailand and Brazil as well as in Mexico for the year 1995/96 with production exceeding consumption worldwide for the second year in a row Sugar production has been increasing steadily in Mexico and has reached record levels in the past three years (1994/95 1995/96 and 1996/97). The largest sugar producing state is Veracruz producing 35–40% of total Mexican production of sugar during the past 10 years The next largest sugar producing state is Jalisco producing approximately 15% of the national total and 13 other states follow The percentage of total production in each of the major sugar producing states during the past 20 years demonstrates that there is some fluctuation in the percentages of production by state showing both fluctuations in area harvested and fluctuations in yields due to different weather patterns Recently financial difficulties at the mills have also contributed to year to-year changes in production levels

Table 2.1 World Raw Sugar Price, by Quarter and Year

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Mean
1975	32.85	18.42	17.08	13.59	20.49
1976	14.16	13.88	10.45	7.8	11.58
1977	8.64	8.96	7.43	7.41	8.11
1978	8.33	7.38	7.23	8.32	7.82
1979	8.09	7.94	9.09	13.49	9.66
1980	20.13	28.18	31.74	36.01	29.01
1981	24.69	16.44	14.25	12.35	16.93
1982	12.43	8.17	6.84	6.23	8.42
1983	6.19	8.93	10.17	8.67	8.49
1984	6.65	5.67	4.21	4.19	5.18
1985	3.68	2.96	4.21	5.30	4.04
1986	5.83	7.45	5.25	5.67	6.05
1987	7.10	6.58	5.80	7.38	6.71
1988	8.84	9.29	11.77	10.80	10.17
1989	10.57	12.23	14.03	14.32	12.79
1990	14.80	14.28	11.28	9.83	12.55
1991	8.89	8.60	9.70	8.97	9.04
1992	8.24	9.89	9.79	8.45	9.09
1993	9.21	11.17	7.47	10.28	10.03
1994	10.93	11.64	12.13	13.80	12.13
1995	14.63	13.70	13.31	12.10	13.44
1996	14.87	12.30	12.34	—	—

Note: Contract No. 11—f.o.b. stowed Caribbean port, including Brazil bulk spot price.
Source: USDA (1996)

Table 2 2 Largest Sugar producing Nations

Country	Sugar Produced 1995/96 (1,000 Mt)	Production Forecast for 1996/97 (1 000 Mt)
India	18 270	17 000
Brazil	13 700	14 500
China	6 750	7 000
United States	6 686	6 604
Thailand	6 300	6 500
Australia	5 136	5 600
Mexico	**4 660**	**4,680**
France	4 601	4 400
Cuba	4 450	4 600
Germany	4 150	4 550

Source USDA (1996)

For descriptive purposes sugarcane production in the Mexican state of Veracruz and the U S state of Florida can be compared In Veracruz approximately 603 500 acres of sugarcane were harvested in the marketing year 1995/96 (October through September) (COAAZUCAR 1996) and in Florida, 417 852 acres were harvested Florida s yield, in terms of short tons of sugarcane per acre was 34 6 for 1995/96 or 84 9 MT/ha (USDA 1996) compared to 66 8 MT/ha on average in Veracruz Sugar mill recovery rates were 12 26% in Florida for 1995/96 and 11 0% in the state of Veracruz

Prior to 1990 sugarcane was harvested by hand in Florida and it still is in Veracruz however Florida producers now harvest 100% mechanically Virtually all production in Florida is on flat land very near sea level while the geography of sugarcane in Veracruz varies from hilly to flat land, from sea level to higher than 5 000 feet in altitude and includes

a variety of soils (Cisneros-Solano 1993) Florida s production instead is nearly all produced on sandy muck soils or histosols which are rich in organic matter and somewhat trickier to cultivate

Overall Florida's production was 1 61 MMT in 1995/96 and Veracruz produced 1 65 MMT of sugar in the same harvest year In sharp contrast however a similar quantity of sugar was produced by seven mills in Florida (Buzzanell, Lord and Brown 1992) and 21 mills in Veracruz Also, this similar quantity of sugar was produced by more than 50 000 producers in Veracruz but only by 133 in Florida

While it may seem surprising that two states apparently so close in production and geography can be so far apart in structure the difference is not so pronounced in the global context. Bartens (1985) categorizes the common structures of sugar industries found in the world into two categories monostructural systems (where > 85% is worked by a single system either miller planters or planters linked with a central sugar mill) and polystructural systems (a mixed system with either a predominance of miller planters, or a predominance of planters) Mexico is described by Bartens as a monostructural system with planters linked to a mill and Florida is described as a polystructural system with a predominance of miller planters In a worldwide comparison Bartens attempts to assess the relative efficiency of the different structures and rates both monostructural systems as superior to either polystructural system However both the systems in Florida and in Veracruz are well-developed Their ability to compete in a global marketplace is mirrored by a strong industry in Queensland, Australia (which has the same structure as that of Veracruz) and in the Dominican Republic (which has the same general structure as that of Florida)

In contrast to Florida, the Mexican system in Veracruz definitely favors and intentionally emphasizes labor over capital. This is seen not only in the different numbers of producers but also in the level of mechanization of sugarcane harvest and transportation. In Florida, trailers are used. Each trailer is detached at the mill while the driver returns to the field to pick up another trailer. In Veracruz, one transportation driver stays in line with each truckload of sugarcane until the cane is weighed by the mill. This sometimes involves a wait of up to three days.

As a final comment on the overall production of sugar in Mexico as compared to that of the United States, it should be noted that, while Florida accounts for almost one-half of the sugarcane production in the United States, its production is less than 25% of total U.S. sugar production and only 12% of overall sweetener production when one also considers the sugar beet and HFCS industries in the United States. Mexico, on the other hand, produces only sugarcane and is just beginning to wet mill corn for HFCS. Veracruz, with about 40% of sweetener production in Mexico, is relatively more important to Mexican production than Florida is to U.S. production.

Mexico in the International Context: Consumption

Driven by production increases, higher incomes, population increases and greater demand for sugar-containing products, such as processed foods and soft drinks, worldwide sugar consumption for 1995/96 increased by approximately 4.5% during 1994/95 (USDA, 1996). Sugar consumption in Mexico is also high by global standards, ranking sixth overall in the world, with a per capita rate of 41.6 kg (91.5 lbs) per year (see Tables 2.2 and 2.3). However, in spite of population increases of about 2.2% per year, Mexican sugar consumption has remained somewhat stable for the past seven years at between 4.26 and 4.32

MMT per year The U.S Department of Agriculture forecasts for 1997/98 are similar at 4 3 MMT The slow growth of consumption can likely be attributed to several different factors (Buzzanell 1995) The devaluation of the peso caused decreases in GDP and this somewhat curtailed consumption The substitution of imported HFCS for sugar especially in baked goods and in states close to the U S border also accounts for decreasing per capita consumption Finally with decreasing tariffs resulting from the NAFTA Mexico has imported more sugar-containing products from the United States

Production consumption net exports and stocks for Mexico for the past 15 years show that for most years Mexican sugar production satisfied Mexican sugar consumption and that neither exports nor imports have ever played a very large role in the sweetener market (Table 2 3) Consumption increased steadily up until the year 1992/93 and then began to stabilize. Production has varied more widely over the same period but the tendency has been toward steady increases, with the period from 1994/95 through 1996/97 showing a noticeable increase in production, departing from the historical trend

A brief comparison of consumption between the United States and Mexico will demonstrate some basic concepts regarding sugar consumption Unlike production in Mexico, statistics on sugar consumption and stocks are not exact The USDA (1996) estimated that in fiscal year 1996/97 Mexican consumption was at 4 2 MMT or 41 2 kg per capita In 1995 industrial use was estimated to comprise approximately 55% of this consumption with 45% consumed in homes restaurants and other places outside of industry Of the industrial users, soft-drink producers were expected to use 57% bakeries 15% confectionaries 13% and others the remaining 15% (Buzzanell 1995) These figures led to an estimated share of 31 35% of total sugar being used for soft-drink production in 1995

Table 2.3 Beginning and Ending Stocks Production Consumption and Trade for Mexican Sugar from 1975 to 1997

Year	Beginning Stocks	Production	Imports	Total Supply	Exports	Consumption	Final Stocks
1975/6	683	2698	0	3381	432	2650	299
1976/7	299	2696	0	2995	0	2660	335
1977/8	335	3029	0	3364	0	2900	464
1978/9	464	3058	0	3522	103	3080	339
1979/80	339	2763	778	3880	0	3125	755
1980/1	755	2518	607	3880	0	3150	730
1981/2	730	2842	470	4042	0	3455	587
1982/3	587	3078	862	4527	40	3300	1187
1984/5	1187	3242	270	4699	0	3260	1394
1985/6	1394	3928	0	5322	192	3510	1620
1986/7	1620	3970	0	5590	505	3600	1485
1987/8	1485	3808	0	5291	967	3747	577
1988/9	577	3678	600	4855	410	3840	605
1989/90	605	3100	1100	4705	17	4038	750
1990/1	750	3900	1400	6050	285	4260	1505
1991/2	1505	3500	275	5280	50	4320	910
1992/3	910	4330	100	5340	0	4300	1040
1993/4	1040	3780	15	4835	0	4260	575
1994/5	575	4556	15	5146	235	4310	601
1995/6	601	4660	130	5391	700	4260	431
1996/7	431	4600	100	5131	300	4300	531

Source: USDA (1996)
*Estimated

In the United States a total of 7 275 MMT of HFCS was utilized in 1995 for food and 8 592 MMT (raw basis) of sugar was used totaling an overall sweetener consumption of 15 867 MMT Per capita sweetener consumption was 65 86 kg with 30 kg per capita sugar consumption and 35 14 kg per capita from HFCS Virtually all HFCS is consumed by industrial users and an additional 58% of sugar consumption was delivered to industrial users (USDA, 1996) Approximately 43% of this consumption is from sugarcane and the remaining 57% comes from sugar beets

A Rich History

Some of the important historical themes relevant to sugar production involve the role of the small farmer and the interaction between the farmer and the state As those roles are changing now it is important to review some of the different colonial and Mexican views of agrarian economic structures

Land and the Small Farmer

The concept of the small farmer originated with the 1567 law decreed in which Antonio de Mendoza then Spanish Viceroy in Mexico created *ejido* common lands to be associated with Indian villages (Parkes 1970) At the same time the European feudal structure was still in place and large tracts of land known as *encomiendas* were being offered to Spaniards to entice them from Spain to the new world (Frank 1979) On the *encomiendos* colonists had the right to collect tribute and sometimes labor from the Indians As the *encomiendos* grew into enormous agricultural haciendas the *ejido* land began to be consumed In the mid nineteenth century the *Ley Lerdo* or Lerdo s law ruled that all existing *ejidos* would be sold This law was alternatively ignored enforced or denounced for

the next 60 years. Through the latter half of the nineteenth century politicians continued to grant land to various favored groups.

By 1914 Emiliano Zapata was organizing his followers (Zapatistas) into bands which took over *haciendas* murdered the administrators and divided the land among themselves. Many of the *haciendas* at this point were sugar plantations so it is possible that the tradition of the small sugar farmer was born here. The *ejido* law. Article 27 of the Constitution was written in 1916, and in the wake of the *haciendas* the new law declared the state to be owner of all lands and waters. The *ejidos* were reinstated and the villages controlled the property right concessions. The native Indian tradition of holding individual plots rather than coordinated communal farming was also maintained.

Though the law existed the *ejidos* were not well-supported and the *hacienda* system was still in control of the vast majority of land. It was not until the late 1930s under the rule of Lazaro Cardenas that larger areas began to be assigned to *ejidos* and that these small holders were also supported technologically and financially in their agricultural efforts (Yates 1981).

Today though it is very rare that any sugarcane grower owns more than 20 hectares of land the original *haciendas* often appear to be in place. This is because much of the land remains under cane cultivation in spite of the land reform. Still about one-half of cane acreage is owned by *ejidatarios* or people living on *ejidos*. Without exception, mill personnel that were interviewed responded that there was slight if any difference between *ejidal* producers and small holders (who owned their land outright) in terms of the ability of the farmer to produce sugarcane.

Government Intervention in the Market

During the post revolutionary period the sugar industry was controlled mostly by large mill-owning families. After a period in 1930-31 which saw large sugar stock increases followed by a drop in world sugar prices the still young revolutionary government began Mexico s long history of supporting both the sugar industry and the sugarcane industry. Various institutions which have provided support to agriculture in general and sugar in particular have developed through the years. Much of this institutional structure is currently in transition.

Cane pricing and payment

The Comite de la Agroindustria Azucarera (COAAZUCAR) is a government organization that oversees the interaction between sugarcane producers and sugar mills. The organization was formed in May 1991. It provides a forum for resolving disputes between mills and growers and ensures that legislation regarding *caneras* is carried out. Examination of some of the historical types of legislation passed concerning *caneras* reveals that the bulk of the legislation is in regard to the system of cane payments (Table 2-4). The majority of disputes surround payment issues. Because payments to producers are tied to the weight of cane, percentage of sucrose and efficiency of mills, elaborate statistics are reported to and maintained by COAAZUCAR. The committee is made up of one representative from the Secretariat of Commerce, one representative from the Secretariat of Agriculture, two representatives from the growers' unions and two from the mill owners' chamber.

Commodity policy

Government commodity policy is officially carried out by three separate ministries working together. The Secretariat of Agriculture, Livestock and Rural Development governs the growing of sugarcane. For example, irrigation and water use is governed by this agency.

Table2-4 History of Cane Payment Legislation

Years	Description of Cane Payment System
1956–1972	Growers are guaranteed a price that is 50% of the price of Standard sugar assuming an 8% recovery rate in the mill
1973–1975	Growers are guaranteed a price that is 50% of the price of Standard sugar based on a recovery rate that is the average of the 5 previous years at the mill with a guaranteed minimum of 8.2%
1976–1979	Growers are paid a fixed price for cane based on a proportion of the sum of guaranteed prices for rice, beans, sorghum and soy with equivalent sucrose contents
1980–1991	Growers are paid according to the base price of a kg of sugar and the recovery rate of the mill. The price is modified every year by the bank of Mexico using the price index and an annual average price. A minimum of 8.3% recovery rate is used and a minimum of 2.6% sucrose loss is used, except for the years 1989/90 and 1990/91 when the minimum accepted sucrose loss moved to 2.5%
1992–present	Growers are paid 54% 55% 56% and 57% of the average sugar price based on the theoretically extractable amount of sucrose for each mill

The Secretariat of Commerce and Industrial Development (SECOFI) controls the prices of primary commodities as well as imports and exports. Meanwhile, the Secretariat of the Treasury and Public Credit collects all taxes and tariffs and issues credit to the industry.

Azucar, S.A.: Marketing monopoly

The first state run sugar monopoly was formed in response to the sugar crisis of 1931–33 which saw a 30% drop in wholesale prices coupled with a 154% increase in

inventories (Antonius-Gonzalez 1997). Mill owners slowly organized in response to the situation and eventually the government intervened to stabilize prices. Azucar S.A. grew out of the Comission Nacional de la Industria Azucarera (CNIA) in 1983 as the then privately owned mills began to default on their loans from the government run financing institution FINASA, in the late 1970s (Singlemann 1995). As this occurred the government gained control of more and more mills.

With the privatization of the sugar mills Azucar S.A. was dismantled in 1991 and the mills once again face the task of marketing sugar. After a half-century of government control the deregulated industry faced a similar situation of growing inventories and price variability in 1992 and it may again in 1998 due to inventory increases. Though the industry still pursues political solutions as a unit, the economic forces of a competitive industry suggest that in the absence of governmental support, prices will fall toward the world price.

Medical and pension benefits for sugarcane growers

The Instituto Medical y Seguro Social (IMSS) is a very important institution to cane growers. The institution provides both pension and medical services to all employees in Mexico and to small farmers who grow sugarcane. Other small farmers in the country are viewed as self-employed or as employers but since sugarcane growers all work closely with sugar mills the mill operates within IMSS as the employer with the growers in the role of employees.

Most sugar mills have IMSS clinics located next to the mills. This special relationship has often been cited as a source of inefficiency in the sugar industry in Mexico (Buzzanell and Lord 1995; Borrell 1991) because it provides incentive for rural families to grow sugarcane solely for the purpose of receiving these benefits, and in doing so, it dampens

the incentives to efficiently produce sugarcane. Furthermore, since benefits are received by all growers regardless of the size of the farm, the IMSS benefits encourage further fragmentation of sugar cropland. A recent study by Singlemann and Nunez (1996) revealed that 62.7% of *caneros* reported that the number one advantage to growing cane was the IMSS benefits while 4.1% said it was the high income from cane and 11.9% answered the secure income.

Government financing

Established in 1963, Financiera Nacional Azucarera, S.A. (FINASA) provides credit to both sugarcane growers and sugar mills. Chollett (1994) argues that the provision of credit was one of several tools the state employed to gradually gain complete control over the sugar subsector. As campesinos were an important part of the stabilization of the Mexican state, the integrated sugar sector characterized the alliance between *campesino* and state. Though this traditional alliance is now in transition due to the mill privatization process, some elements remain, one of which is FINASA and the access to credit.

Approximately 80% of sugar mills currently gain credit from FINASA and another 20% from FIRA, which provides credit to all producers of agricultural commodities. What is unique to FINASA and the sugar industry is that the credit is still managed by the mills, putting mills into a parafinancial role. Because the mills need to provide supervision of cane growing in order to ensure a continuous supply of raw material throughout the harvest season, the same supervisors coordinate and issue the credit from FINASA to growers. This usually takes the form of biweekly payments to growers in the form of inputs, money for inputs and wages for labor performed in the field. This credit is then subtracted from the growers' sales of the sugarcane and is repaid to FINASA by the mills. While alternative

financing structures are under consideration for the future many mill owners and managers are willing to pay the administrative costs of managing the credit in order to maintain the incentive for cooperation between grower and mill that offering credit provides

Understanding the Present

In keeping with the market based economic restructuring and export-oriented industrialization (EOI) policy of the government (Otero 1994) changes are occurring in the industry at a variety of levels Some of the changes are described below along with a discussion of their significance The reforms are organized into three general themes These are the mill privatization, efficiency enhancing strategies and land reform

Privatization The Fundamental Shift

When the 44 government-owned sugar mills were sold between 1988 and 1992 many of the buyers were related to industrial consumers Pepsico and Coca Cola franchise holders purchased many mills to supply sugar for soft drinks Other mill-owning groups are linked to Bimbo and Empresas Gamesas the two largest Mexican producers of cookies and sweet snacks such as coffee cakes These new investors lacked the experience of the older sugar industrialist families and the period of adjustment is arguably still under way between the growers and the new owners (Chollett 1994)

Currently 62 5% of the sugar producers are at least somewhat integrated with either a major soft drink bottling consortium or one of the two large baking concerns (CNIAA 1997) The other 37 5% produce and sell their sugar independently and often are associated with the old families who have been in the sugar industry for decades Some of these owners never lost their mills to Azucar S.A. in the 1980s

In the state of Veracruz of the 21 mills operating ten are part of vertically integrated consortiums Four of these ten are owned by Grupo Escorpion, the largest sugar producing company in Mexico. 23 5% of the national sugar supply and, with the four mills in Veracruz 23% of Veracruz s production is produced by this group Escorpion is integrated with Pepsico as is Grupo Mexico which owns seven mills nationwide two of which are in Veracruz One Veracruz mill is part of Grupo Beta San Miguel integrated with Bimbo and one is owned by Plaza, integrated with Coca Cola Two more are owned by Santos which is integrated with Gamesa. The other 11 mills are divided among five more sugar producing consortiums which are all independently operated In some cases the mills themselves may be owned independently and the owners collaborate in the form of a consortium. In other cases one owner will own and operate several mills

Competition

Benefits that can be anticipated from the mill privatization stem from the increased competition that can be expected from the move A government worker running a mill may not work as hard at lowering costs or developing new systems as someone who stands to make a profit When coupled with price liberalization this is anticipated to bring improved efficiency to the industry Less efficient companies will contract while more efficient companies will want to expand to increase their profits. Furthermore privatization means that the mills may be less politically motivated Anecdotal evidence suggests that, in the past mill worker jobs were bestowed as favors by the government aggravating an already weak and inefficient system Owners may also be expected to take better care of a mill in terms of maintenance and repair of equipment than might be expected of a government A recent study by Antonius-Gonzalez (1997) concluded that privatization had improved productivity

Creating distance from the government

As the industry s move away from the government improves firm-leval production efficiency so will the government s move away from the industry result in a more efficient execution of the government s duties For example, the environmental protection agency in Mexico (PROFEPA) is now in a much better situation to enforce environmental standards When the government was in the role as a potential polluter and simultaneously enforcing pollution standards there was not much incentive to pursue enforcement because the government would then be forced to pay the costs of cleaning up the problem With privatization the government has shut down some of the mills for effluent violations in those mills that have distilleries (Diario Xnlnpa, 1996) There is also much speculation that within a few years the burning of sugarcane prior to harvest will be banned

Cooperation and contention in the industry

The Camara National de In Industria Azucarera y Alcoholera (CNIAA) is the chamber of sugar mill owners and it plays a significant role in coordinating production nationwide The chamber provides a forum through which mill owners can discuss common issues of the market they face In the same way that sugarcane growers unions represent growers the interests of mill owners are represented by the chamber of mill owners..which serves as a forum and a representative body It interacts with the government in questions of policy with growers in terms of negotiating and between individual mills especially in questions of marketing strategies The chamber organizes export allocations recommends prices for various grades of sugar and tries to organize voluntary marketing allocations during the months just after the harvest to prevent price-cycling throughout the year

The chamber has the potential to act somewhat like a cartel but fails to do so because it cannot control the supply of sugar very well and because of competition between mill-owning groups. Because the chamber has no real enforcement capability, mill owners have the opportunity to cooperate with marketing agreements when it is convenient to do so and to cheat when it is inconvenient. One explanation for this is that competition between mill-owning consortiums is tough because many are vertically integrated with competing sugar-consuming companies. For example, some consortiums are integrated with Pepsi Cola while others are integrated with Coca Cola.

The chamber of mill owners maintains influence with the federal government and policy concerns because the government is interested in the healthy survival of the industry for employment purposes and for the country's supply of an important energy providing staple. The government also maintains industry involvement in the areas of union organization (not all unions but the two largest), the complete coordination of EMSS and the setting of trade policy through the SECOFI.

Efficiency Enhancement

The efficiency enhancing strategies described here are designed to improve the economic incentives within the sugar producing subsector so that efficient production is encouraged. The most important of these is probably the change in the system of payments for sugarcane, from a by-weight system to a by-sucrose-content method. This, together with the altered benefits structure and price liberalization, suggests improved productivity though less security for growers and millers in the future. Facing the increased risk of market forces implies both an increased risk of failure and an increased probability of success.

System of payment

One of the most important mechanisms at work in the system is the cane payment mechanism. In 1991 the Decreto Canero changed the system of payment for sugarcane from payment by weight to payment by sucrose content. Paying individual growers according to sucrose content discourages the inclusion of rocks and other extraneous matter with the sugarcane as it enters the mills. It also provides growers with an incentive to harvest and transport their cane quickly before sucrose is lost. However, the current system allows mills to take the average sucrose content for the whole mill and to pay all growers according to this average. By averaging, the incentive to improve sucrose content may be outweighed by the temptation to "free ride". The free rider problem arises when benefits accrue to an economic agent who does not bear the full cost of the benefits. In this case, a sugarcane grower could benefit if mill wide sucrose contents improved due to a majority of growers working hard to harvest and transport their cane properly. The improved sucrose content would be reflected in higher cane payment for all growers at that mill. The "free rider" grower could benefit whether or not he improves his personal sucrose content. The free rider problem is that, therefore, no single grower has incentive to improve sucrose. Worse still, growers might be inspired by the increased payments earned by their fellow growers to add more extraneous matter into their own cane loads, thus actually lowering the mill wide average sucrose and therefore lowering mill-wide cane payments.

The system of payment for sugarcane naturally affect yields. Yields can be thought of either in terms of the tons of sugarcane produced per hectare or the tons of sugar produced per ton of sugarcane. Both measures can be combined in a yield measure defined as the tons of sugar produced per hectare. Yield in terms of sugarcane weight per hectare is expected to

be positively affected by a system of payment that is based on cane weight while the yield in terms of percentage of sucrose in sugarcane may not be affected. Similarly yields in terms of sucrose percentage will be affected by a system that pays for sucrose but cane weight may not be affected. In any case, the current system is a mixed system which that fails to reward an individual grower for increased sucrose content but does reward all growers (according to weight) if the mill wide average sucrose percentage increases. Most industry participants interviewed are in agreement that this system of payment is theoretically flawed and the system should eventually move to one of individual payment based on sucrose content. The reason given for slow transition however is that the necessary equipment for sampling each growers' cane for sucrose content is very expensive and neither growers nor mills have been eager to pay for these machines.

Furthermore two other convincing arguments are made in favor of maintaining the current system. First, sugarcane reaches a peak sucrose content (maturity) in the middle of the harvest season though the mill receives cane for about six months. Individual payment would mean that those growers whose cane was cut early or late in the season would be at a disadvantage. Compensating calculations could provide a means for compensating for harvesting inequities as is done in some other countries such as Australia (Cortina-Gallardo 1996). Sugar mills do try to plant a balance of early, medium, and late maturing varieties to maximize sucrose content throughout the harvest season as well as stagger planting schedules, but the grower may not be willing to switch varieties to conform with the predominant variety in the nearby area. To minimize harvesting inefficiencies due to location, concentration of similar maturing varieties is necessary.

The second reason to support the current averaging system of payment is that growers tend to work together since very few have even 10 hectares of land. The averaging system provides incentives for neighbors, friends and *ejidatarios* to share technological insights, teach one another and uniformly plant varieties.

The determination of domestic sugar price also affects the system of payment for sugarcane. Growers are paid for sugarcane based on 57% of the price of a ton of standard (99.3% - 99.5% sucrose) sugar. This agreement was negotiated prior to the liberation of the sugar price and prior to the current apparent trend in sugar exports. With a market determined sugar price it became unclear which sugar price was to be used as the base price from which to determine cane payment. On March 26, 1997, SECOFI published the following formula for determining the price to be used as a basis for cane payment (Diario Oficial, 1997):

$$P_r = \alpha * \bar{P}_n + (1 - \alpha)\bar{P}_r^e$$

where P_r = wholesale price per kilogram of standard sugar to be used as reference for cane payment during the harvest.

α – expected portion of harvest to be consumed nationally, or =1 if expected consumption is greater than expected production.

$\bar{P}_n$ = reference price for standard domestic sugar calculated by comparing the July – September average price of the previous year with the current year.

$(1 - \alpha)$ – expected surplus as a portion of production.

$\bar{P}_r^e$ = expected export price of sugar, which is a weighted average of the U.S. price and the world price (weighted by the percentage of exports expected to go to each sector.)

Consequently the domestic price of sugar is an essential component of the base price of sugar used in sugarcane payment Each mill corrects this price for their own particular theoretic ability to extract sucrose before the final payment to growers is made In this way mills which are not as new and do not have the best equipment still have incentive to use their existing equipment in an efficient way and they are not punished for lack of investment capital At the same time mills are not able to pass their own inefficiencies on to their growers. Using the previous system of sugarcane payment called KABE regardless of how much sucrose was in the sugarcane mills had only to pay for that which the mill was able to extract from the sugarcane Hence growers in a region surrounding an inefficient mill had little incentive to produce high-sucrose-content sugarcane If the mill was run poorly growers would also 'pay' for this in terms of lost revenues The new system called KARBE corrects for this and equalizes sugarcane payments to growers throughout the country

Benefit reform

Beginning with the harvest season 1993/94 the industry began shifting the burden of payment for IMSS from the mills to the growers During the harvest season 1994/95 the mills paid 50% of the IMSS quota growers paid 25% and the government paid 25% The percentage paid by mills dropped to 33 3% then to 16 6% in the 1995/96 and 1996/97 harvest seasons and again to 0% during the 1997/98 harvest season (IMSS 1993) The state percentage remains at 25% throughout the period and the growers portion will steadily increase from 25% to 75% through the period In exchange for the loss of this financial responsibility mills will pay growers more for their sugarcane The price of sugarcane has gradually moved from 54% of the price of sugar to 57% over the same four harvest seasons

It should be noted that cane growers have provided as strong a support base for the institution of IMSS as the institution has for the growers. Because the governmental restructuring aims at making IMSS more competitive rather than dismantling it entirely it is important that growers now represent an essential component of the market for medical services provided by IMSS. If IMSS can maintain this market share, the survival of the institution will look more probable.

The economic significance of the reduction in the role that sugar mills play between growers and IMSS remains unclear. At present, although the mills no longer pay IMSS, they are paying growers more. And growers are still receiving a special rate for IMSS, which is less than the amount a non cane-growing farmer would have to pay. Furthermore, because mills usually keep all of the books for growers for credit purposes, there may be little difference between mills paying growers who then pay IMSS and mills paying IMSS directly. At present, growers enjoy IMSS services. IMSS needs constituents and IMSS facilities are already in place in mill environs. In a long run framework, however, there will be room for a decreased role of the IMSS benefits in sugarcane production. If land concentration occurs, the role of IMSS is likely to decrease. Also, the law regarding the interaction between sugarcane growers and IMSS is still being negotiated. There has been speculation that, in the future, IMSS will not accept any new sugarcane growers (other than the existing listed growers) to prevent further fragmentation of the land among offspring. Another future possibility is that only *caneros* who own some minimum sized farm would be eligible (to prevent the same type of further fragmentation).

If the role of IMSS declines, this will affect growers in the sense that their pension and health benefits will become less associated with their sugarcane crop. This, in turn, may

influence the average size of a [redacted] farm since growers who merely own the land to receive benefits might sell their farms to growers more interested in farming On the other hand, if many current growers are truly absentee merely owning the land on paper to receive benefits the change may be merely an accounting convenience since in such a case current absentee farmers would not be participating much in the industry anyway

Price liberalization

The price of sugar remained under government control until February 1996 In the wake of the economic crisis caused by the peso devaluation SECOFI retained control of pricing longer than had been originally planned. Because sugar had always been part of the government market basket of staple foods care had been taken to restrict imports and to support the price to ensure ample supplies of sugar at prices that were low enough for consumers This put millers and growers in a difficult position particularly in the 1970s and 80s when inflation was extremely high (Borrell 1991) During that period, input prices were allowed to increase while the price of sugar was not Indeed this phenomenon was instrumental in the defaulting of so many mills to the government financing agency and the subsequent government control of mills (Singlemann and Otero 1995)

This problem reappeared in 1995 when inflation hit a remarkable 57% (Banco de Mexico 1997) with GDP declining 6% During this period the official price of sugar was allowed to increase only 25 7% from November 1994 through November 1995 (from statistics from COAAZUCAR) During this year some mills simply did not pay growers causing major conflicts that required long hours of negotiations between grower unions and mills. During the same period some of the mills which had been sold on credit, were returned to government control and resold

It is difficult to understand what the exact consequences are of an economic crisis such as that experienced in 1995 because estimates of economic indicators vary so widely Inflation estimates vary and, instead of 57% 35% inflation was estimated by PNC Bank (1997) in Pennsylvania. Mill administrators that were estimated the rise in input costs from a range of 70–200% for 1995

In order to facilitate a secure environment for sugar to be bought and sold without government control a sugar exchange agency or trust was established in 1994 by the chamber of mill owners and is being slowly adopted by the industry Formally the objectives of the agency called Fideicomiso para el Mercado de Azucar (FORMA 1997) are fourfold. 1) To provide indicators of price movements through the daily reporting of sales to the exchange from all mills, 2) to check and monitor mills, providing certificates of securities for mill financing 3) to develop a futures exchange to help stabilize prices and 4) to become a sugar exchange By 1997 the first and second objectives were achieved, but the exchange service and the futures exchange had yet to be realized. Due to the slight cost of insuring sales through the clearinghouse, only 100 000 tons of sugar were sold through the exchange in 1995 This represented about 2% of all sugar sales in Mexico

By 1997 all but five mills in the country reported their sales to FORMA. All information except the name of the buyer is reported. This allowed the exchange to complete an analysis of price fluctuations once the price had been liberalized. Their analysis identified four stages for the 1996 growing season

> Stage 1 Suggested prices (January – February)—Prices for "standard" and refined sugar all increase by about 100 pesos per ton (or 6.7%) immediately after price liberalization

Stage 2 Harvest (March – May)—Sugar inventories increased with the final months of harvest, prices were maintained steadily and TEP exports were sold

Stage 3 End of Harvest (June – August)—Refined sugar price increased as did standard price with increased storage and finance costs Mills paid growers for crops Exports continued.

Stage 4 Inventory Increase (September – December)—Prices of standard and white sugar drastically fell 16% as producers endeavored to decrease storage costs and SECOFI requested the reimporting of the lower grade sugars Refined prices were maintained but would likely fall without a change in conditions

These stages clearly demonstrate that the structure was in place for market forces to determine prices. It is very likely that a similar cycle of price fluctuations will occur annually When the futures exchange is operating this should aid in smoothing out some of the fluctuations The stages experienced in 1996 however, generally are expected to provide a pattern and guide to future price movements

Land A Pivotal Issue

One of the most interesting facets of the recent production enhancement, in the form of increased field yields and factory recovery rates, is that it has occurred while the number of producers has increased Earlier in the chapter mention was made of the tumultuous history of agrarian policy with dominant sentiments alternatively favoring support for small and subsistence farming and support for large commercial farming for economic development The current wave of sentiment involving the reform of Article 27 of the constitution might be interpreted either way Two alternative results are. 1) The small holders finally given full property rights to the land will be able to develop it for long lasting optimal use 2) Small holders will exercise the freedom to sell the land, or be compelled to sell by lack of small scale economic opportunity and land concentration will finally occur enabling commercial production to reach its potential The sugar industry has

a particularly interesting set of features that may help to define the outcome of this major policy change for the sugar subsector These features are presented below

Reform of Article 27

The reform of Article 27 in the Mexican Constitution means that *ejidatarios* or users of communally managed property are now allowed title to their land and ownership in the traditional sense. Previously *ejidatarios* had access to the land they farmed but did not possess enough property rights to the land to optimize its value into perpetuity For example, there were restrictions on capital investment in the land and a landowner was not allowed to use the land as collateral for other types of investments This situation further degraded the value of the land to the owner/user suggesting a pattern of even less optimal use

The reform of Article 27 now states that *ejidal* land owners may have title to their land sell it, rent it and/or use it for collateral as they would any other asset. This development implies a new opportunity for the concentration of land holdings which may have advantages in terms of economies of scale. It also implies a possible aggravation of urban migration if small landholders who compete with larger land holders take the opportunity to sell their land and leave the rural areas for better employment opportunities believed to be available in the city

Concentration of land?

Of the 54 549 Veracruz sugar producers in 1993/94 34 858 (64%) were producers identified with the *ejidal* system As established in 1917 the state owns the land and communities farm it communally or individually as they see fit Until recently sale or leasing of the land was prohibited and the size of land parcels was restricted *Ejidal* sugarcane producers in 1987 averaged 4 6 hectares per grower as compared with the 9 7-hectare

average for the remaining number of private producers (INEGI, 1988). Less than 10 years later the average size of land owned by a *canero* had dropped to 3.8 hectares over all producers, both private and *ejidal*. In the state of Veracruz (COAAZUCAR 1994).

Within the sugar industry concentration of land is one of the most interesting concerns. In the present context for many reasons. On the one hand, concentration of land would increase the unit of production and might reduce the transaction costs currently associated with coordinating the many small farmers currently farming disjointed plots using different sugarcane varieties and making uncoordinated management decisions. On the other hand, sugar is symbolic and has a long history of coordinated decision-making at the grower level. It might be more difficult to convert to completely new technologies and management approaches than to maintain a traditional pathway, modifying existing practices to meet changing market conditions and demands. Evidence for this argument is perhaps found in the recent successful harvests.

Finally, there is some evidence that informal land markets within the ejidal system have been operating for quite some time. These may have come about because sugarcane growers have always enjoyed strong support from unions and government and because the land in cane always has been quite highly valued with growers doing relatively well compared with farmers of less secure crops. It is possible that the informal markets were functioning fairly well since markets are an effective way to allocate valuable goods. If this has been the case, then once again the expected change resulting from the new legislation may well be less noticeable than in the case of other agricultural crops. This situation highlights the uniqueness of sugarcane acreage as an agricultural case.

What is the real unit of production?

The new law that now allows the renting of land has produced [redacted] of renters. Note that, for the present, IMSS benefits still accrue to the owner [redacted]. An interesting phenomenon here is that mills are now renting land from some of their [redacted] and in at least one case the mill rented all of the land from their growers (Flores [redacted] 1995b). This raises the question of the real unit of production. If decisions regarding input use and timing of the harvest are made at the mill, is not the mill the unit of production? If this is the case, there may be little economic gain to be expected with further land concentration. It is worth acknowledging that at least one noted Mexican researcher is of the opinion that, within the next 10 to 20 years, the mills will gain control of the land in sugarcane as they have in other countries.

Summary of National Changes

Changes currently taking place have altered the fundamental structure of the Mexican sugar industry, allowing for much greater diversity in production and increased competition (Figure 2-1). Until 1990, control of the industry lay primarily with the government. Many of the supporting institutions of smaller scope were also managed by the government. The government is therefore at the top of the industry management triangle, controlling all phases of production below it. The incentive to comply with dictates of the government were strong and thereby discouraged the advantages of innovation through competition and through the attraction of profits. While growers maintained good bargaining power through their unions, these unions were (and remain) linked to the political parties, which, in turn, maintained their own strength through access to devoted union members who were voters.

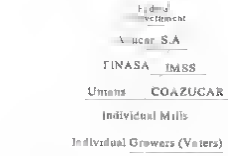
[illegible] (post 1990) the loss of [illegible] [illegible] decision making beg[illegible] [illegible] [illegible] management triangle is no longer [illegible] though the [illegible] With privatization of the mills mill owners are free to [illegible] event than [illegible] [illegible] not simply to function in accordance with government interests This is [illegible] [illegible] shifting of the mill owners segment at least partially away from government [illegible] With this move should have come some of the anticipated increases in [illegible]ity—improved recovery rates at the mills higher sugarcane yields and superior harvesting strategies Growers too are somewhat freer to act in entrepreneurial fashion although they are still beholden to both union and mill. For this reason growers are shown also to have shifted partially out from beneath the power of the federal government though they are still directly beneath the mills

Looking Ahead

In the context of the restructured sugar industry we see that many of the structures could either be interpreted as departures from prior structures or as only slight modifications To a large extent some future events will probably determine the direction of those interpretations Comments are made below on the relationship between structures and economic viability on the role of alternative sweeteners and on the future of financing

Structure and Viability

The link between the current restructuring of the industry and improved economic opportunities in the industry is curious because it appears to be a causal relationship although the direction of the causality is unclear Has the liberated market caused the productive



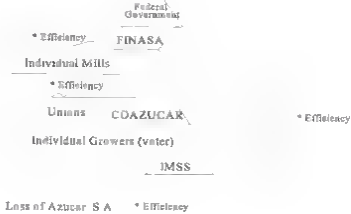


Figure 2-1 Schematic Representation of Structural Changes in the Mexican Sugar Industry

[redacted] Or is the improved efficiency [redacted] industry really w[redacted] [redacted] a smooth transition to the new [redacted] structure? The former seem[redacted] [redacted] but the latter might be true [redacted] following sense. Resources may be flowing into the sugar industry because of the potential access to the U.S. market with NAFTA. These may have shown up primarily in the investments in new equipment in mills and in research and development, both of which manifest themselves in enhanced efficiency. Hence investment—rather than actual changes in the incentive structures such as the new cane price legislation and the reform of Article 27—may underlie efficiency enhancement. If this is the case, it raises the question, "What will happen if the U.S. market is not received?" If HFCS imports foil the achievement of 'net surplus producer' status, then such opportunity-based efficiency improvements are likely to disappear along with U.S. market access.

Alternative Sweeteners

The relative prices of sugar and the substitute calorie sweetener, HFCS, may be even more important to the industry than investment or restructuring. Forecasters expect that during the 1997/98 marketing year, domestic HFCS could rise to 350,000–400,000 MT (Garcia-Chavez, 1997). Imports of U.S. HFCS have been temporarily slowed as the Mexican government has returned to high tariffs on the imports while an anti-dumping suit is being investigated. However, a spokesman from the chamber of mill owners recently stated that, even with the tariffs, HFCS is still cheaper than sugar (*San Diego Union Tribune*, 1998). The soft-drink industry alone estimated that it needed 1.4–1.6 MMT of sweeteners for 1997. If HFCS were to maintain its lower price status, it is likely to achieve a significant portion of the Mexican sweetener market in the next 20 years. The soft-drink industry is the logical

place for HFCS to saturate the Mexican market and that alone [illegible] sugar currently sold. Because of the vertical integration between sugar mills and soft [illegible] manufacturing, HFCS may not completely saturate the market.

The Future of Financing

Another important element to affect growers is the financing agency FINASA. FINASA provides credit to growers and channels the credit for growers through mills. This puts the newly privatized mills in the interesting position of having leverage granted through the government with their growers. It also means that the government has less control over the capital and anecdotal evidence suggests that sometimes the government funds have been misused by the mills.

Ultimately FINASA is slated to be dismantled and financing for the sugar industry will occur within the private banking sector and the public agricultural finance organization FIRA. When this occurs, it is hoped that growers will acquire their own financing and leave the mills out of the role of parafinancial institution thus freeing them to focus on sugar production. At present this development seems at least 10 years away, and neither growers nor mills are currently prepared for or enthusiastic about the changes in the financing structure. Growers still enjoy the security of mill financing and in addition to the appeal of having excellent credit themselves the mills enjoy the added bargaining power they have with growers through control of the credit. The sugar mills themselves are also affected by FINASA in that FINASA provides financing for mill related activities, such as updating equipment and expansion of capacity. The effect of mills on growers, yields and costs will be discussed more fully in the next chapter where the relationship between growers and mills is addressed.

Summary

Through the history and future direc t sugar production in Mexico several themes emerge a land tenure that emphasizes small holders yet has a *hacienda* structure superimposed on a history of government price support that is being dismantled and turned over to more volatile more international market forces government financial and legal support designed to protect the interests of small farmers and the removal of traditional market constraints on productivity such as poorly defined property rights poorly designed payment systems and monopoly/monopsony power structures The issues of land concentration and of the international market forces remain unresolved yet key factors determining the future of the industry The protection of the small farmers combined with the removal of the market constraints however creates an interesting new mixed marriage of traditional political goals with a modern competitive economy Given the recent trends in productivity this seems to be a happy marriage

CHAPTER 5
THE CRITICAL RELATIONSHIP BETWEEN GROWER AND MILL: TECHNOLOGICAL CODEPENDENCE

The state of Veracruz has been a sugar producing center for Mexico for many years. The first sugarcane planted in the country is said to have been planted in Veracruz by Hernan Cortez in 1523 (Bassalto 1993). Until it closed in 1990 the national sugar research station (IMPA) was based in the state of Veracruz just outside of the city of Cordoba which serves as the industrial home base for eight sugar mills. Yet the state's tremendous diversity in terrain also makes it a special case and it is possible that sugar production in other states may eventually supersede Veracruz's historical lead in sugar production. On the other hand, as exporting becomes more and more likely in Mexico's future, the state will maintain an advantage by its proximity to the Port of Veracruz, the largest port in Mexico.

Sources of production enhancement in the sugar industry are many. Inside the mill, improvements come with machinery modernization and maintenance which occurs with investment. Investment is in part encouraged by reducing costs and increasing profits which is happening in the milling sector through reduction of mill worker staff, among other reasons. These reductions in staff are due to both increasing output per worker and to increasing mechanization. The tendency is likely to plateau at a point when most mills have been renovated and the number of workers will have reached an equilibrium. Because firms are now private, information on renovation and investment is difficult to come by and

difficult to predict Hence the emphasis [illegible] technological [illegible] will instead be the many growing and harvesting technological improvements occurring in the field Grouped loosely into cultivation improvements and harvest improvements a few of the most important enhancements in each classification are discussed below

Perhaps the most strikingly different facet of the Mexican sugar industry when compared to the U S industry is the relationship between growers and mills. Mexican mills and growers are bound to one another in a relationship characterized by distrust and adversity yet at the same time interdependence and paternity It may be that the future of the Mexican industry actually depends upon this relationship. If the relationship strengthens, both parties are well situated to reap the benefits of their cooperation and if the relationship breaks down, both sides may wind up losing Analysts of this relationship recognizes that it is a kind of social technology which can improve or decline but it varies along with the other types of technological change

The foci of this chapter are the technological innovations occurring in Veracruz and a consideration of the source and future of technological innovation. To orient the reader to the condition of the industry a section—which describes the heterogeneity of mills and of production in Veracruz—has been provided at the beginning of this paper

Heterogeneity of Sugar Mills in Veracruz

An appreciation of the variety of sugar mills in the state of Veracruz can perhaps be best shown by presenting descriptive statistics for the various mills and then comparing and contrasting the costs of production for the 1989 through 1994 harvest seasons Though very diverse technological innovation occurs at almost all of the mills and perhaps can be considered more valuable in light of the diversity of structures through which it operates

Descriptive Statistics

The 21 active sugar mills in the state [illegible] vary in size, geographic factors and productivity. The largest mill, San Cristobal, with a reputed capacity of 20,000 tons of sugarcane ground per 24-hour period, was considered the largest capacity sugar mill in the world until the mid 1980s (Bartens 1985). In the milling season 1995/96, the capacity of San Cristobal was reported to be 14,327 tons per day, due to ongoing renovation with the mill. By contrast, La Concepcion, a small mill near Jalapa, reported a capacity of 1,423 tons per day, less than one tenth the size of San Cristobal. In 1995/96, six mills in the state possessed a capacity above 5,000 tons per day, seven more reported capacities between 3,000 and 5,000 per day, and the remaining eight mills have capacities at less than 3,000 tons of sugarcane per day. Of the 223,515 ha. planted in sugarcane, San Cristobal accounts for 37,379 ha., three other mills control areas greater than 15,000 ha., four operate with less than 5,000 ha., and the remaining 13 mills account for somewhere between 5,000 and 15,000 ha. each.

The state of Veracruz produces sugar at altitudes ranging from sea level to 1050 m (over 3400 ft) (Bartens 1985). Soil types vary with representative soils from all major soil types and receiving rainfall varying from 20mm to 200mm per month. Some of the land is flat and swampy, such as in the Papoloapan River Valley in the south (San Cristobal, Tres Valles, San Gabriel), and some is hilly with great variation (El Carmen, Mahuixlan, Motzorongo).

In terms of efficiency, sugarcane per hectare, recovery rate (or percent of sugar extracted per ton of sugarcane) and overall sugar produced per ha. are all good measures of efficiency. Yield in terms of cane per hectare is one area of focus for improvement. In

[illegible] tons per hectare [illegible] Chiltoluapam [illegible] 101.82 tons per hectare (Table 3.1). Factory [illegible] did not vary quite as widely with the range for 1995/96 running from a low of 9.69% sugar produced per ton of sugarcane at Independencia, to a high of 11.87% at El Higo. In terms of sugar produced per hectare, both El Modelo and La Gloria have high overall sugar per hectare yields with 12 tons of sugar and 11.34 tons per hectare, respectively. At the other end of the spectrum, Chiltoluapam and Independencia report 4.31 and 4.33 tons/ha, respectively.

The mills El Modelo and La Gloria possess a number of similar traits. They are situated next to each other in the flat coastal plain near the port of Veracruz. A distinguishing feature of these mills is that they both have higher rates of irrigation than any others in Veracruz. The irrigation facilities have been in place for more than 30 years, and though once managed and maintained by the government, they are now being transferred to the cane growers who use them. The growers will act in user-groups to maintain and manage their own irrigation (CNDA, 1993).

The mill Independencia has undergone considerable transition in the past years, as this mill is located in the town of Martinez de la Torre, where citrus crops compete for the land use. The mill has been renovated and improved, however, and a transition arrangement has been made between sugar growers and mill. Growers will receive less than the 57% of the price of sugar for their cane, while Independencia rebuilds its strength as a mill. Anecdotally, the mill also received a special arrangement with the mill workers union allowing the mill to operate with less labor than is nationally permitted.

Table 3 1 Descriptive Statistics for the Mills of the State of Veracruz 1995/96

Name of Mill	Area (ha)	Yield (MT) MT/ha.	Recovery Rate Sugar/Cane	Sugar (MT) MT/ha.
Central Progreso	9248	50 79	11 00	5 54
Constancia	9011	59 79	10 58	6 11
Cuatotolapam	9199	44 56	9 63	4 31
El Carmen	4955	98 54	10 28	10 19
El Higo	10612	51 76	11 87	6 14
El Modelo	10199	101 82	11 77	12 00
El Potrero	21215	70 20	11 68	8.24
Independencia	4226	49 71	8 69	4.33
La Concepcion	3333	91 84	10 32	9.51
La Gloria	7533	95 77	11 81	11.34
La Providencia	9883	59 52	11 17	6 68
Mahuixtlan	3335	88 89	11 20	9 98
Motzorongo	16039	58 78	10 90	6 43
San Cristobal	37379	57 88	10 70	6.22
San Fnco el Nrjl	7189	67 64	10 22	6 92
San Gabriel	5894	56 31	10 62	6 00
San Jose de Abajo	6441	70 13	11 64	8 20
San Miguelito	6294	85 85	11 21	9 62
San Nicolas	5263	65 85	9 99	6.61
San Pedro	9961	69 19	10 41	7 21
Tres Valles	16834	71 73	11 44	8 24
Zapoapita	9497	73 65	11 08	8 16
Total Veracruz	223515	66 86	11 01	7 38
Total Nacional	573846	70 03	10 89	7 65

Source COAAZUCAR (1996)

Mill renovation and improved irrigation in addition to the technological innovations described in the previous section are sources of the increasing overall measures of efficiency throughout the state. In some areas of the state, improved irrigation is not possible as all available water has already been allocated to industrial and urban uses. In other geographical regions of the state however, such as the Papaloapan River basin where San Cristobal, San Gabriel and Tres Valles mills are located, there is water available, and growers and mills are working together to devise schemes for developing and paying for improved irrigation. It is possible this is in part motivated by the reform of Article 27, which would now enable ejiditarios to benefit in the long run from improved capitalization on their land. When the land was technically community owned there may not have been incentive to pay up front for improved irrigation.

Costs of Production of Sugarcane

As the sugar mills in Veracruz vary in size, geography and productivity, so they vary in costs of production and prices paid for sugarcane. Overall averages for the state of Veracruz for the years from 1987 through 1994 reveal steadily increasing nominal costs and steadily increasing nominal prices (Figure 3.1). Unfortunately the data for more recent years is not available, however it appears that percentage of profit to each grower has slightly increased since privatization.

While overall statewide trends tell one story, the heterogeneity of the mills is also an important point when addressing the issue of costs. Costs vary from mill to mill; prices of cane can vary (the better mills must pay more; some mills chose to pay more), and since 1991 the price of cane is based on its sucrose content; hence higher quality cane is more costly to

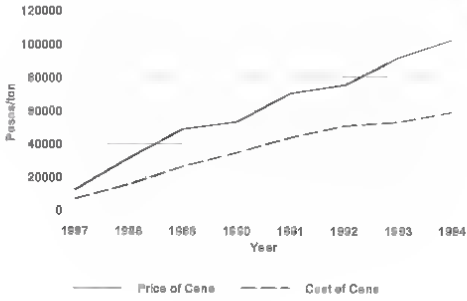


Figure 3-1 Costs and Prices of Sugarcane Production in Veracruz, Mexico 1987 through 1994
Source COAAZUCAR (1994)

mills) and percentages of profit varies across mills and across time (Table 3 2) This latter po nt is important when considering the ability of growers to anticipate prices and costs

It must be remembered that the contracting mill will determine the required inputs to cane production and consequently determine the costs The mill is also usually the buyer for the inputs, and so if input prices increase the mill can pass these costs on to the grower That is the grower is the ultimate consumer for inputs but the mill does the buying and this may constitute market failure because the consumers are not free to purchase optimal quantities they demand. Furthermore with typically high inflation rates and a government

Table 3 2 Costs per Ton and Profit as a Percentage of Revenue across Mills 1986 through 1994

Name of Mill	Mean Cost per Ton	Standard Deviation	Profit as a percent of Total Revenue
Central Progreso	35795	19706	437
Constancia	31569	17881	476
Cuatotoluapam	31908	15231	410
El Carmen	31842	15002	464
El Higo	40028	22454	330
El Modelo	36418	18985	475
El Potrero	35663	18304	486
Independencia	35422	16709	251
La Concepcion	35448	19617	455
La Gloria	40322	20952	433
La Providencia	38443	21426	391
Mahuixtlan	36702	18370	391
Motzorongo	35911	18079	397
San Cristobal	36686	20062	347
San Gabriel	33211	18452	462
San Jose de Abajo	36209	19117	469
San Miguelito	33793	18333	500
San Nicolas	32406	16304	459
San Pedro	35187	18342	361
San Francisco el Nrjl	32555	16797	403
Tres Valles	41748	19202	313
Zapoapita	39722	23570	328
Total Veracruz	36122	18709	414
Total Nacional	36989	19276	411

Source COAAZUCAR (1995).

controlled sugarcane during the years 1987 through 1994) it was possible that both mills and growers would be caught in a squeeze between a fixed sugar price and rising input costs. This does not appear to have occurred very frequently, which could be because of strong grower union negotiating powers.

Overall average costs per ton for the 1987-94 period were $36.122 Pesos for the state of Veracruz, just slightly less than the national average for the same period. Profits as a percent of total revenue were 41.1% for the period, very close again to the national average of 41.4%. More noticeable is again the range between mills for average costs and average profits per ton for the same period. The least cost average mill was El Carmen with an average of $31.842 for the period, and the highest cost mill was Tres Valles with costs averaging $41.748 for the period.

For profit as a percentage of total revenue, Independencia has the lowest value at 25.1%, and San Miguelito has an average value of 50.0%, nearly twice that of Independencia. Because much of the difference in prices is based on differences in sucrose content, it is easy to see why the issue of averaging sucrose content over the whole mill is so important. In Veracruz many mills overlap in areas of supply and neighbors often take cane to different mills. It is not uncommon to see trucks loaded with sugarcane passing each other heading in opposite directions on the roadways as cane from overlapping mill areas is harvested.

Mill and Grower Relationship

A wide range of types of relationships occur between growers and mills, and these often date to an original sentiment between the community and a large land owning family who owned the mill. Similarly, the new mill owners seem to generate a kind of culture in each sugarcane growing area, which tends to either inspire an overall favorable or overall

[illegible] The general themes of [illegible] strong unions and respect for the [illegible] life emerge as important [illegible] of the grower/mill relationship today and these themes appear to be very traditional in origin

Antagonism and Distrust

On both sides of the grower/mill relationship there in general exists a healthy amount of distrust Growers interviewed and spokesmen for growers tell many stories of the mills failure to pay agreed amounts and of the many scandals designed to take advantage of the growers by not paying them their full due On the other side while mill staff usually acknowledge that some growers are hard working and devoted the general characterization of cane growers from mill personnel is that growers they have historically been favored by the government for no deserving reason Sugarcane is recognized as the "lazy man s crop" which does not require much care or attention but is bound to bring at least something to even the laziest of growers This skepticism on both sides of the grower/mill relationship has the one advantage of keeping both parties fairly vigilant

Purse strings of power

The growers play an obvious role in determining yields as they are the ones who own the land and manage or oversee if not perform the production of the crop Growers decide which varieties to plant, when to replant (usually every five to seven years) and if and how to irrigate they contract the harvesting and they often perform the work of weeding plowing and the application of herbicide pesticide and fertilizer

Mills play a very important management role also because it is the mill inspector who interacts with the grower and determines the time line used to perform all of the tasks

[redacted] prescribes the [redacted] technical [redacted]. The mill also [redacted] With [redacted] natural [redacted] power element of [redacted] the mill is in the position to [redacted] credit to growers. Given that sugarcane farming is a low income activity the credit [redacted] the mill's quite a bit of power.

In spite of this power and the ability of the mills to determine the input combination and the timing of the cultural practices, the grower is the one who directly affect yields because mill inspectors often oversee 200 or more growers. Frequently growers have land [redacted] their crops, such as maize and beans for personal consumption and to other cash crops, [redacted] such as tomatoes, coffee, citrus or livestock. Because credit is given in the sugar industry but [redacted] for most other farm enterprises it is often said that inputs credited a grower for sugarcane [redacted] always go for cane production (Borrell, 1991).

Another problem is that especially during years of difficulty in the national economy when they are cash poor growers will sell the profits to their sugarcane up to four years in advance. In these cases the inspector will still oversee the production process and whoever performs the labor will receive the wages for it. But the final payments above all of the costs will end up in the hands of the person who bought the rights to the net profits. Such a situation provides very little incentive for growers to concentrate their energies on the crop.

Cheating, monitoring and enforcement

While inspectors do what they can to prevent the various kinds of abuse of the credit system growers are at the same time watchful that the mills do not try to cheat them. Growers are frequently suspicious about the accuracy of the scales at the mills (since payment is still primarily made according to weight of cane) and union offices in all of the

mill environs are staffed with lawyers needed to aid growers with collecting and accounting correct pension benefits from the mills. In the mill laboratories where testing for sucrose content is done, union representatives are permanently assigned to watch the process and prevent cheating. In spite of this, there are still accusations (probably well substantiated) of corruption—that the union people accept bribes allowing mills to cheat or that mill staff themselves fudge numbers or lie about the amount of sucrose being recovered. Through all of these devices, it is difficult to know which side is getting away with cheating the other and to what extent. However the intensity of the relationship is epitomized by the armed security guards posted at the doorways of most mill offices.

Indispensable Unions

The two major unions for cane growers are the two nationwide unions for campesinos (small farmers) which are associated by the ruling political party, PRI. The two unions, CNC and CNPR, are for ejidal and private property owners, respectively. These unions usually have offices in the mill environs and represent growers in daily interactions with the mills. The unions participate in the coordination of the harvest, the resolution of social security and medical conflicts, the issuing of credit to growers from mills, the payment process and in any other legal conflicts that arise. Many of these issues are taken up within "production committees" which meet regularly at each mill and are composed of mill representatives, grower representatives, mill worker representatives, cane-cutting representatives and others.

Since the mill privatization, growers have begun to organize other unions which are not directly responsive to PRI, but to other political parties. As yet these unions are small in number compared to the other two. While there is some competition between the two, and

n slightly different philosophical foci to each they often are [redacted] the grower population and interests that are remarkably similar

The unions represent powerful political factors in the pro[redacted] appears to be continuing as rarely a harvest season begins that is not [redacted] strike for one reason or another Usually it is for a higher cane p[redacted] benefit share but in 1997 the unions threatened to protest the NAFTA export [redacted] the United States Because of the large numbers of growers the unions represent a substantial voting block and a well organized political faction with a long history of activism

Household Realities

The reality of sugarcane growing households bears some description as does life in the area surrounding the mills Several points can be made that sugarcane tends to be a household seasonal crop that mill environs are an engine of rural development and that many people other than cane growers depend on the industry

Sugarcane growers

Of the 54 459 sugar producers in Veracruz in 1993/94 we can assume each producer really represents a family of about five, including one man one woman and several children In addition to the growers the industry employs cane cutters mill workers and truck drivers (33 601 14 638 and 18 837 respectively in 1993/94 in Veracruz alone) In 1993/94 sugarcane accounted for over 406 million dollars worth of income for the state (COAAZUCAR, 1994) the largest single income generating crop A more recent statistic suggested that in Mexico as a whole, more than 308 000 people depend on the sugar industry for their livelihoods Although one usually does not see women working in the sugarcane fields,

approximately 30% of ca[illegible] much. Often th[illegible] men or send a male family [illegible] land.

Not just growers

From interviews with [illegible] growers during the sugarcane harvest [illegible] that many growers also have [illegible] laborers, maintenance people or a variety of other economic activities associated with the sugar mills. In one medium sized mill in Veracruz, a survey of the shops and restaurants in the immediate neighborhood of the mill revealed that 46 people were employed full-time with their shops and another 15 were employed part time. The larger mills have generated full towns around them. Housing and schools are often centered around the older mills, and in conjunction with the IMSS health clinic, these small towns are quite sufficient. Cane cutters are another entire population sector who depend on the sugar industry. Cane cutters are usually migrant laborers who live in states outside the cane growing states.

Household security strategies

At times the sugar industry with its support of small producers has been characterized as a kind of rural welfare program. Another possibility is that sugarcane has for a long time been a crop which builds and maintains household security. One of the reasons that growers tend to decrease but not eliminate their sugarcane cropland is that sugarcane is very resistant to weather extremities such as the "El Norte" storms which can devastate a fruit crop. Sugarcane has traditionally provided household security because it requires very little maintenance yet provides certain income. In this way, if household members become ill or if all household members become unexpectedly employed or otherwise occupied, the crop will still grow and still provide some income for the family.

Summary

Essential to understanding the subsequent descriptions of technological enhancement is a sense of the reality that faces Mexican sugarcane growers. There will always be tension between mill and grower yet both are usually bound together not only by economic necessity but by history and geography. Interdependence is respected and communication is maintained through the unions and other social structures such as mill inspectors and production committees.

Cultivation Techniques

Some of the technological improvements occurring in Mexican sugarcane fields takes the form of mechanization. Mechanization—in the form that Florida has mechanized sugarcane cultivation in planting, tilling and pesticide applications, for example—requires a different social and geographic structure than is found in Mexico. The mechanization in Florida has occurred 1) on flat land, 2) in zones of continuous sugarcane acreage where the average unit of production is around 2,500 acres and 3) in a society which does not place a high value on the creation of low wage jobs.

In Mexico on the other hand, much of the land is hilly and/or rocky. Also the land parcels are small, dissimilar and disjointed. Furthermore, industry people in Mexico often cite regional employment benefits as a reason for favoring a labor-intensive technology over a capital-intensive one. Some good examples of currently popular cultivation technology improvements are 1) planting of improved varieties, 2) conservation of seed cane and 3) low or no-till techniques. Each is described below.

Improved Varieties

Planting improved varieties is a critical activity on the minds of all mill field supervisors and inspectors. Because of the crop cycle a mill inspector has but one chance in six or seven years to convince the grower they work with to change the variety planted. Meanwhile growers who are doing well are reluctant to risk changing to something new. Still newer varieties are more disease resistant and, though they may be of lighter weight, generally have higher sucrose yields. If this is the case, growers are additionally reluctant to switch varieties as they are still paid based on the weight of cane they grow. If mill wide sucrose quantities improve, this will be reflected in payments but there is still substantial economic incentive to stick with a heavier variety regardless of sucrose content.

Another benefit of the improved varieties is to provide a better mix of early-medium- and late-maturing varieties. Nationwide, Flores-Caceras (1995) estimates the breakdown between early-, medium-, and late maturing varieties was 23% to 71% to 6%. Many mills are hoping to improve on this and thereby be supplying their mills with mature cane for a longer period of time. The concept is explained using this simple graph (Figures 3-2a and 3-2b).

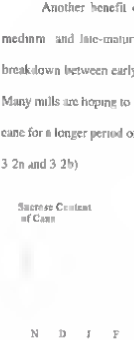


Figure 3-2a Sucrose Levels in Sugarcane of One Variety

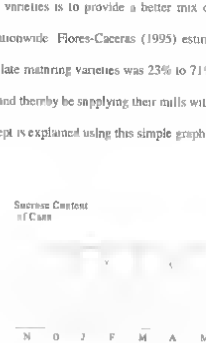


Figure 3-2b Sucrose Levels of Varieties with Differing Maturity

The picture on the left represents the maturity of cane of one variety While the mill may stagger planting and thereby stretch out the period of maximum maturity there will still be much higher sucrose contents during the period from January to March than there will be during the beginning or the end of the harvest season The picture on the right depicts a scenario with different varieties maturing at different times with the result that the mill harvests mature sugarcane for a larger period during the harvest

Conservation of Seedcane

Conserving seedcane is a simple new technological development being promoted throughout the country The technique involves spacing 20 cm chunks of seed cane approximately every 60 cm apart as opposed to the traditional method of laying the seedcane roughly end to end when planting This reduces seed cane costs by 66% The fewer plants compensate in size for their smaller number since they need not compete with so many other plants for their resources Labor is saved because the plants do not need to be thinned Most of the planting is done by hand to "provide employment for the workers" and because rows are generally too narrow for a tractor to pass through

No and Low-till Techniques

A number of mills in Veracruz are employing some variety of low till technique One mill is using a green harvest (as opposed to burning the cane before harvesting) and then leaving the leaves and tops of the sugarcane on the field where they are rather than cleaning them off the field The advantages to this technique are as follows a) There is no need to remove the leaves and tops b) the leaves and tops provide some fertilizer so that less fertilizer is needed, and c) the leaves and tops shade the sun so that less herbicide is then needed. Difference between the traditional method and the new method on a per hectare basis are

demonstrated in Table 3 3 The new method advocated in the table also employs the seedcane conservation methodology described above The cost comparisons in Table 3 3 were used by one mill to explain to growers the advantages of the new method Another advantage of not burning cane is more global in terms of air quality Adapting to a green harvest technology may have cost advantages in the future as pollution controls may restrict burning

Table 3 3 Costs and Differences Between New and Old Method of Tending Sugarcane

	Traditional Method		New Method	
Activity	**Labor (hrs.)**	**Cost**	**Labor (hrs.)**	**Cost**
Raking and Burning Trash	5	$100	0	$0
Weeding (2X)	20	$400	10	$200
Herbicide Application	5	$100	2	$40
Herbicide	5 liters	$426	2.5 liters	$213
Thinning Plants	10	$200		
Rowing Trash			5	$100
Green Harvest (hrs/cost)		16/$320		
Burned Harvest (hrs/cost)		8/$160		
Totals (Green/Burned)	$1530/$1360		$873/$713	

The traditional method involves raking and burning "trash" or the leaves and tips This requires approximately five hours of labor at a cost of $100 which is unnecessary in the new method. Less labor is used in herbicide application and less herbicide too Plants need to be thinned out using the old planting strategy (this cost is only incurred during the first year of the plant), and trash must be raked into a row during the first year when using the new strategy

The total costs are presented for both methods considering the case of both a green harvest and a burned harvest. Harvest costs are the same in either case and so for both methods the burned harvest is cheaper. The totals using a green harvest are $1520 for the traditional method, as opposed to $873 for the new method. For a burned harvest, the totals are $1360 and $713 using the old and new strategies respectively. The field supervisor from the mill providing the information argued that the yields for both methods were the same per hectare or if anything they were higher using the new method.

Other variations on this type of technology are that some mills advocate spraying herbicide on the leaves and then plowing the leaves under and still others are cleaning the leaves mulching them with soil and then replacing the mixture on the field.

Harvest Technologies

Because the fields are so small and sometimes discontinuous the harvest is a crucial step in cane processing and the target of much research and experimentation. Three of the most common areas of improvement described below are: grower training and the organization of harvest groups, green harvesting and the use of cane holders for automatic cane loaders.

Grower Training and the Organization of Harvest Groups

Since the Decreto Canero in 1991 growers are paid according to the quality of cane produced, or the sucrose content. The problem with enacting this strategy completely is that it will involve one more level of quality testing and measurement at the mill and, in the minds many growers, one more opportunity for the mill to short-change them. Also many growers feel they should not be penalized for owning poorer lands which are not capable of producing high yields.

In spite of this resistance many mills feel that their best long run strategy is to educate growers about the sucrose content of sugarcane and the importance of transporting already burned and harvested sugarcane as quickly as possible to mills to prevent further sucrose loss These mills would like to move toward the day that the mill merely assigns growers a date upon which the cane will be accepted at the mill leaving the rest of the decisions to the growers As an intermediary step mills are encouraging the organization of harvest groups which coordinate machinery and labor for the harvest among themselves with harvest group representatives acting as intermediaries with the mills. The mills still do all of the sampling and testing of the cane to determine the harvest schedule but with harvest groups the idea is some of the equipment and labor will be managed by the groups Perhaps most importantly the harvest groups should begin to plant all of the same varieties so that they can be farmed together

Many people suspect that averaging sucrose contents over growers within the same harvest group will be the next logical step in a slow movement toward payment of individual growers on a sucrose content basis Another advantage is that by removing the mill from some of the harvest management sabotage burning of the cane will be discouraged At present mills are often forced into harvesting prior to schedule because the burned cane loses sucrose content rapidly

Green Harvest

As shown in Table 3-1 harvesting sugarcane without burning it first is a more costly harvest process though it also has advantages The advantages are primarily that cane which has not been burned both possesses more sucrose and more importantly loses sucrose more slowly once cut A major problem with sugarcane harvesting is that sucrose content is lost

from the moment the cane is cut and consequently it is important to ensure the cane is ground within about 48 hours. This requires complicated organization of the harvest and transportation processes, much of which has to be decided at the last minute due to changing weather patterns where rain impedes fire. Burned sugarcane also begins to lose its sucrose and must be cut as soon as possible after the burning. All of this coordination must occur keeping in mind the objective of maintaining a steady stream of cane to the mill so that the machinery and staff is never idle. One sugar researcher estimated an average of 6 to 7 tons more of sugarcane is harvested per hectare when the cane is cut green, which more than compensates for the extra harvesting costs.

Loaders and "Burros"

In Veracruz, while almost all of the sugarcane is harvested by hand, it is not all loaded onto the trucks by hand. Automatic cane loaders are popular and can be used in places where mechanized harvesting is not feasible. Loaders save 40–50% of the labor required to complete the harvest. However, the automatic loaders do not screen the cane the way laborers can, and so the quality of the cane is not quite as good when it reaches the mill. In an effort to resolve some of this problem, a simple device has been developed and has been adopted by many mills. It is a metal rack, which is used in the field to lift the sugarcane off the ground when stacked, and the loader then lifts the cane off the rack instead of off of the ground. This prevents entrance of extraneous matter into the mills. The technology was developed in Veracruz by a mill manager.

Summary

These six examples of new technologies are by no means an inclusive list. There are new developments in the area of pest management, various types of mechanization, irrigation

and many more The examples mentioned here however are good exam[illegible] location specific low technology improvements which are common and [illegible] part account for the improvements occurring in both field yields and [illegible] recovery rates

Research and Development

Since the national sugar research institute closed in 1990 (IMPA) there has been much concern in the industry about the future of research and development While the loss of public research is a valid point of concern other structures are joining in to replace the loss What is clear at this juncture are two points First that sugar researchers are networked among themselves and though IMPA is closed the researchers are generally still working elsewhere and are communicating among themselves Second, new institutions are stepping up to fill the void left by IMPA s closure Below is a list of existing national structures which are performing research and extension in this area

Sugar producing Consortiums

Because many of the new mill owners are part of larger consortiums the consortium is now becoming a source of research Some larger consortiums may have separate research facilities and even the smallest of mills generally has an experimental plot where the chief of production is happy to report on the latest trends, problems and technologies occurring in that particular mill This source of human capital is important to note because given the geographic diversity of the mills in Veracruz, it is often that a technology used at one mill is completely inappropriate in another For example mill field engineers are always clear about the number one threat to their crops be it pest or disease but this ranges from the painted

Mosquito to leaf rust to rats across the state Frequently what is the number one problem in one mill is nonexistent in another

Association of Sugar Technology Researchers

There exists an association of sugar technology researchers in Mexico which regularly has well attended regional and national meetings Papers are presented on all varieties of technological innovations from the low input strategies to biological control to payment mechanisms It is unclear to what extent technology is shared at these meetings—some mills or consortiums may guard some of their innovations carefully—but the community of researchers is still bound with familiarity and the regular meetings help foster this spirit of shared knowledge

Owners' Research Station

Sugarcane variety breeding is primarily being provided by a research station in Tapachula, in Southern Mexico which is sponsored by the chamber of mill owners Some industry experts have expressed concern about the long run adequacy of this station It may indeed be limited but technicians at the mill level are again beginning to participate in research at the encouragement and support of the chamber of owners

Universities and Other Research Institutions

A number of other research institutions participate in sugar research and extension throughout the country For example the University of Veracruz conducts short courses in sugar management and technology for industry people Recently the University began a Master's program which covers all facets of sugar production field, factory and market. This latter program is sponsored in part by GEPLACEA, a cooperative organization of sugar exporting countries from Latin America and the Caribbean Faculty for this program come

from other universities in Mexico, such as the national agricultural university in Chapingo. The Center for Research and Technological Assistance in Queretaro (CIATEQ) has assisted some mills in designing innovative harvesting techniques and agricultural research on several topics such as irrigation occurs within the Institute of Postgraduate Research centers throughout the country.

Looking Ahead

It may be possible that several shifts in the relationship between sugarcane growers and mills will continue to develop in directions that improve social efficiency. Improvements in social efficiency can be thought of as improvements in sugar production which do not sacrifice social objectives. Assuming that one of the social objectives is to maintain a large number of small producers (while not necessarily all existing producers), that another is to reduce the level of antagonism between grower and mill and that still another is to reduce the bureaucracy at the mills, the socially efficient path may include some coordination among growers and a decreased involvement of mills in the actual cultivation process.

Planting Together, Payment Together

A number of proposals are being discussed to maintain the efficiency of a competitive industry within the constraint of the large number of farmers. While the inspector/grower relationship has certain advantages, it is costly in that it is time-consuming. Inspectors interviewed reported spending from 50% to 90% of their time filling out the paperwork for their growers' accounts. Some mill personnel instead are looking forward to the time when growers will only receive credit if they have organized themselves into groups with a minimum of 20 hectares to be farmed together. At this point, the logical transition to payment for sucrose content could also begin to occur using the larger farming units.

Similarly financing can begin to occur directly through the cooperative groups The ejidal tradition will be very useful in this transition if it is to develop

It must be remembered however that the ejidal system is not one focused on cooperative farming nor has there been an indigenous tradition in this direction Instead the tradition has been based on individual plots within a communal land use structure For this reason it may not be realistic to expect that cooperative growing will come into existence The most obvious alternative would be to see land concentration in the hands of fewer growers

Declining Focus on Mill

If the mills could remove themselves from the parafinancial role, the inspectors could instead focus on their task of increasing yields and efficiency might improve again Ultimately the mills may remove themselves from growing and harvesting of any cane though this alternative is probably very far in the future At present any decline in the roles that mills play will need to be filled by someone primarily to take the lead in directing cultivation Yet there is no strong candidate to do this other than the mills and until growers begin to take the entrepreneurial role or to develop their own institutions to replace the lead role of the mill this structure is perhaps too firmly associated with sugar mills to be replaced any time soon

Mills too have traditionally been institutions of rural development stimulating road building schools and clinic locations (Perdomo-Bueno, 1995) In some cases the majority of houses in the mill environs are also owned by mills But this role is declining with the mill privatization and with other trends in rural development nationwide. Mill owners are not anxious to continue in their role as maintenance companies and thus housing is slowly being

sold too It is inevitable that the mills generate economic activity around them and will remain focal points of rural economic activity but in the future the difference may be that this activity will be economically independent of the mill

Summary

The relationship between grower and mill within the sugarcane industry in Mexico is undergoing a shift which transfers some responsibility and potential reward toward the grower and away from the mill There is some debate about whether this can occur or not that is whether the growers are capable of accepting increased responsibility There are also mixed feelings among mill staff as to whether this is desirable or not Certainly the history of antagonism suggests that growers have been ready to accept greater responsibility The adversarial nature of the relationship also suggests potentially optimal market outcomes The crux of this relationship actually occurs between the mill inspectors and the growers with which the inspector works If extension inspectors were to be allowed to redirect their efforts away from bookkeeping activities and toward extension activities social efficiency might increase Social efficiency may also decrease if the alternative scenario occurs which is vast concentration of the sugar land into the hands of a few This might improve technical and economic efficiency though the social objective of contributing to the well being of rural families may be overlooked in such a scenario

CHAPTER 4
THE MEXICAN SUGAR INDUSTRY IN A SYSTEMS ENVIRONMENT

Having covered the changing sociopolitical structure that influences Mexico's sugar industry in Chapter 2 and the grassroots production dynamics in Chapter 3, the focus of this study now turns to an economic analysis of the forces which drive the entire system. A broader understanding of the complete set of mechanisms at work attempts to shed light on the full implications of the various changes now occurring and the possible implications of future economic transitions. The first part of the chapter describes the components of the system and how they influence each other. The following section presents the recent structural changes occurring in the industry and how the impacts of these changes may reverberate throughout the system.

A Systems Context for the Sugar Industry

The major components of the sugar industry interact in a complex web of linkages and transactions. While all elements ultimately affect all other elements of the system, the linkages (arrows in the diagram) represent important relationships between varied behavioral, institutional and functional components. Each component is discussed below in the context of its systemic links. A diagram (Figure 4-1) that depicts these relationships provides an abstract view of this system.

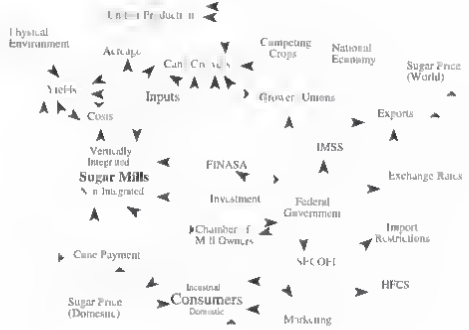


Figure 4-1 Systems Diagram of the Mexican Sugar Industry

Physical Environment

The physical environment or geography of a sugarcane grown in [illegible] important role in determining sugarcane yields. The type of soil, topography, temperature, availability of water, as well as quality of the resources and seasonal timing and stability of all vastly important.

Rain

For example, the authors of a field manual for sugarcane production in Mexico produced by the national sugarcane research institute (INIFAP) state that the ideal conditions for production are long hot summers with adequate rain during the growing period (March through September) and a dry climate—sunny and cold but not freezing—during the period of maturation and harvest (October through March) (Garcia-Espinoza 1984). Rains during the harvest interfere with burning schedules which occur immediately prior to harvest and which, if followed, maximize the sucrose content in the sugarcane. Conversely, not enough rain inhibits production of sucrose early in the development of the plant. More subtly, late rains will increase sugarcane yields in terms of weight, but not necessarily increase the quantity of sucrose proportionate to the increased weight. Rains are also important in Mexico because less than 40% of harvested area has any irrigation available.

Soil and climate

Soil type and climate affect yields as different types of soil are more or less conducive to cane production and provide better or worse habitats for the various plagues and pests that afflict the crop (e.g., Painted Mosquito and Yellow Leaf Rust). Topography also determines yields largely through its role in constraining cultural technologies. In some states, such as Sinaloa, the sugarcane acreage is flat and firm, which is appropriate for mechanized

harvesting and for irrigation. Much of the land in other states however is hilly [illegible] swamp like all of which restrict mechanization and in doing so affect yields.

Yields

Other components of the system play an important part in determining sugarcane yields. These are the system of payment growers the mills and other inputs such as fertilizer pesticides and cane varieties. Much of the discussion of how growers and millls collaborate to influence production is covered in Chapter 3. The role played by the system of payment is also described earlier in Chapter 2 but a brief summary of these concepts will serve to explain the diagram.

For the purpose of understanding the diagram the term "yield" can be thought of in its composite form in terms of tons of sugar produced per hectare. In this sense mills not only influence yields indirectly through growers but also through the effectiveness of their own milling processes. The collaborative process between growers and mills of harvesting the sugarcane will also play a very important role in determining yields.

The system of payment for cane plays a large role in influencing yields. The yield concept sugar produced per hectare is the productive objective and yet the mixed payment system still rewards growers by weight of cane. Hence if the system were to only reward sucrose content (the sugar producing component of sugarcane) more sucrose might be produced than under the current system. For example the tip of the sugarcane is a fibrous sponge-like piece of the stalk which has no sucrose in it. Because of its sponge like quality it is actually detrimental to sugar production because while generating no sucrose in and of itself it soaks up sucrose in the grinding process and actually decreases the amount of

sucrose which would otherwise be extracted. Under the cur[illegible] n grower will actually be rewarded for including these tips by [illegible]

Costs

Yields most directly affect costs. If yields per hectare improve [illegible] same then the costs per unit of output are decreasing. Costs of cane are b[illegible] have the greatest impact on growers. Costs however are becoming more important [illegible] system becomes more market-driven because absolute costs play a role in determining competitiveness in both the domestic and the world market. For this reason costs are depicted as influencing exports in the diagram.

A dotted line indicates that costs should affect sugar price determination. This has probably not yet occurred because the price of sugar has only recently been determined by market forces. If costs of milling drop as they might be expected to with decreasing numbers of laborers, then a competitive market can be expected to result in a lower sugar price. This would then affect the price growers receive for cane, because the cane price is set at a fixed percentage of the sugar price. In this case, it is interesting to note that due to the fixed ratio of cane price to sugar price, growers would prefer that millers reaped higher profits than for millers to allow prices to fall.

Competing Crops

Crops which compete with sugarcane for land use affect growers in terms of the intensity of inputs used for sugar (such as time and labor), which depends at least partly on the availability of credit in the industry of the competing crop. Additionally, competing crops are part of growers' ever changing optimization schemes and may occupy more or less of land traditionally used for sugarcane. The best example of this can be found in the northern

part of the state of Veracruz which since the 1980s has been more and [illegible] citrus production Here land used for sugarcane dropped from 30,000 ha [illegible] sugar mills to about 5500 ha at present with one mill having shut down Growers in the region matter-of factly state they look at relative prices, anticipate relative prices between cane and citrus and allocate land for each crop accordingly Because citrus prices are anticipated to decline relative to sugar some of the land which converted away from sugar is currently being replanted to sugar

Especially because of the medical and pension benefits provided by IMSS and the access to credit, it is not likely that growers will shift all of their land out of sugar More likely is that they shift the majority of their land out of sugar while preserving some sugarcane in order to receive benefits This strategy doubly hurts sugar mills not only is the land in sugarcane decreased, but the remaining land is less compact The disjointed plots create an economies of scale disadvantage because of the increased costs of transporting equipment and work crews around to many number of small plots It is much easier to harvest and organize cultivation when separate plots are next to one another

Grower Households

The national economy also influences the importance of sugarcane to a family because events like the recent peso devaluation and economic crisis threaten household security A related effect may be that the number of growers increases without a parallel increase in sugarcane acreage Due to families splitting up small cane farms among offspring families in efforts to spread the social security benefits to a wider group

Grower unions are both the representative group for growers and the governing bodies for growers In this way the two distinct elements of the system affect each other

In the diagram (Figure 4-1) a double line connects consumers with mills to signify that the vertically integrated mills are consumers too. Consumption is divided roughly evenly between domestic consumers who use sugar for household consumption and industrial consumers who use sugar as an input to another product such as soft drinks or baked goods. The industrial users who are also sugar mill owners have distinct interests from the other industrial users who have no particular allegiance to sugar (Antonius Gonzalez 1997). Hence it is the integrated mills who can also be considered consumers.

Consumers

Overall consumption in Mexico is still expected to remain flat or slightly decrease for the 1997/98. This is due to substitution of alternative sweeteners, to the economic crisis and declines in GDP and to increased imports of sugar-containing products. As seen in the diagram, these factors which determine consumption probably in turn determine the quantity of exports more than anything else (see Chapter 7).

Federal Government

The federal government plays a major role in this system, and again, some of the institutional details of this role are covered more fully in Chapter 2. Briefly, the government policy affects exchange rates, which play an important role in the significance of the world sugar price, which then affects exports. The federal government also directs the policy of SECOFI, which regulates imports and exports, IMSS, which provides medical and pension benefits to growers, and FINASA, which provides financing to the industry. In turn, the federal government is influenced by growers through their unions and by the chamber of mill owners.

Using the System as a Cognitive Tool

The recent major developments in the Mexican sugar industry affect components of the system differently. Four current developments will be considered in terms of how they may influence the entire system as diagramed: the newly liberated price of sugar in Mexico, the new system of payment for cane, changes in social security access and structure, and the new land tenure system with its implications for land concentration.

Liberated Price of Sugar

The price of Mexican sugar has been controlled by the government up until 1996. From the systems diagram we can see that the chamber of mill owners, consumer costs and world prices all influence the price of sugar. The system embodies how the sugar price affects cane payment to growers, the mill owners and consumers. Following the flow of arrows, the cane payment than affects the mills, the yields and growers. Yields affect costs, costs affect growers, and costs affect exports.

Suppose the price of sugar increases. The payment for cane will automatically rise, too, inspiring, even in the short run, greater intensity of inputs and higher yields. Higher yields suggest either an increase in exports or an excess of supply. In the case of excess supply, this would place downward pressure on prices. In the case of increased exports, however, at least two different scenarios are possible. First, it is possible that the increased exports would go to the world market, and then, in accordance with the formula for cane payment, prices to growers would fall, thereby dampening the initial anticipated increases in yields. The second possibility is that some of the exports would go to the U.S. market, where the price would be comparable to the Mexican sugar price, or higher. In this case, there would be no secondary dampening effect on cane production.

On the consumption side we can see from the diagram that consumers would also be affected by an increase in sugar prices In turn consumer behavior impacts HFCS consumption and in this scenario industrial consumers would very likely use more of the HFCS substitute Conversely if the price of domestic sugar were to fall (for example due to an unwillingness to export or failure on the part of SECOFI to grant export permission both creating excess supply) this would impact cane payment and consumers most directly Cane payment would decline favoring less intensive use of inputs, hurting yields increasing costs and decreasing exports At the same time consumers would be more attracted to sugar and likely purchase less of the substitute These scenarios are addressed theoretically in Chapter 7

With the aid of the diagram analysis of the impacts of price changes can be summarized as follows A higher domestic price would result in increased supplies and increased exports though a higher price would hurt consumers and encourage the use of the substitute Uncertainty surrounds this scenario however since the possibility of exporting to the US is not guaranteed Exporting to the United States would not have the dampening effect on production through lower prices to cane growers that exporting to the world market would have A lower domestic price would help consumers and discourage the use of the substitute while discouraging production and decreasing exports This latter situation could produce the countervailing result that decreasing the quantity of exports to the world market would increase cane payments and encourage supply The opposite would be true for a decrease in exports to the United States—ultimately this would discourage supply

Change in the System of Payment

The system of payment for cane has a history of slow moving changes. The current system is distinguished by three relatively new developments. First, there is a movement toward payment for sucrose content as opposed to weight of raw material. This mechanism provides motivation for better harvesting techniques, planting of better varieties and reduction of extraneous materials. The second new development is that the mills must pay according to the amount of sucrose they theoretically can extract rather than what they actually extract. The third new development is that the base sugar price from which cane prices will be taken is newly defined in accordance with the weighted average equation discussed in Chapter 3.

In the diagram, the system of cane payment is shown to influence cane growers' yields and sugar mills. The scenario considered is a dynamic progression toward payment per individual grower for quality of sucrose. This is an ongoing process which most industry analysts agree will continue regardless of other industry-wide events. While ultimately moving toward a system which will pay growers according to the sucrose content each produces, the process may include moving from mill wide sucrose content averaging to smaller groupings of averages such as harvest group averages or field averages. Under this scenario, mills may have to pay more for the raw material, but they should get more for their money.

Growers will be affected because the incentive to free-ride will be decreased, bringing "good" farms and farmers higher incomes than at present. Farmers with poorer management will receive lower incomes. It would, on average, bring lower incomes to farmers with poorer lands and higher incomes to those owning superior lands. Such higher incomes would

provide incentives toward specialization of the industry in the hands of "better" farmers. Ultimately the tendency might be toward greater concentration of land and possibly toward changes in acreage farmed due to rental and purchase. Experience shows that the sucrose content payment policy might also cause complaints from farmers with poor lands to turn to their unions.

Yields in terms of sucrose should also increase due to efficiencies resulting from changes in the payment system. Improved yields would stimulate cost decreases, making export of sugar more feasible.

Change in the Role of Benefits

It is possible that some marginal farmers on marginal land who merely maintain land for the purpose of receiving IMSS benefits may exit when facing changes. This situation may impact acreage planted to cane. Also farmers on good land with high opportunity costs may convert their cane to the competing crops (e.g., citrus in Veracruz) as IMSS benefits become more difficult to receive. A loss of acreage can affect mills as mills need steady supplies of sugarcane to be efficient. Mills however much prefer better, more concentrated lands to work with, rather than fractioned, marginal or even mediocre quality land.

Hence the two major impacts that can be predicted to be associated with the decline of the mill/IMSS relationship are a) change in the land with marginal lands moving out of production and b) decreased role of the unions. Both of these effects may be overstated, however by looking at the changing numbers of producers, because the number of official producers is artificially inflated at present.

Reform of Article 27

Returning to the systems context for the sugar industry (Figure 4-1) the change in article 27 can be thought of as a change in the Federal Government policy toward growers. This policy directly affects growers unions IMSS the chamber of mill owners and the [illegible] of production (the latter through land tenure legislation) Indirectly the change in policy is likely to affect a) cane growers b) yields costs and exports c) the sugar mills and possibly d) the domestic price of sugar Growers will be affected through unions access to IMSS through the mills and through lower costs if economies of scale exist

Summary

The set of relationships shown in the systems diagram demonstrate that there are three components of the system which have more interrelationships associated with them than the others Cane growers Sugar mills and Yields While critical components in the system they also signal the rise in emphasis on efficiency These components could be respectively representing the social economic and technical efficiency measures of the system The priority placed on growers, grower households and incomes remains an important component of this industry hearkening back to its historical roots in agrarian reform The sugar mills represent the new emphasis being placed on economic efficiency brought about by the government s new economic restructuring policy And the technical efficiency—the relationship between inputs and outputs or yields—is something for which both mills and growers naturally strive in order to improve their respective social and economic efficiency

At this same time the role of the government is definitely declining though not entirely removing itself from the industry Hence through the complex system of traditional

economic and political signals the new Mexican sugar industry is responding well to the market-based pressures it faces as a result of the structural changes By maintaining some of the original components of the system such as the growers unions public financing and public governance of the payment to growers the new components of the system—new land tenure, new structure of IMSS, the new sugar price and the new system of payment—appear to be generating the expected and desired results or at least demonstrating a potential to do so in the future

The diagram used here is helpful in understanding the complicated system as it relates to current questions about the future ability of the industry to compete with new components of the overall system such as exports U.S sugar prices and competition from HFCS It is no panacea and care must be taken in the interpretation As a working policy and management tool further validation and revision would be appropriate and necessary As the dynamic system expressed by the Mexican sugar industry continues to evolve the challenge to policy makers and industry managers will expand

PART II

CHAPTER 5
THE MEXICAN SUGAR INDUSTRY IN A 'FREER TRADE' ENVIRONMENT

Trends toward freer trade are now popular because both parties participating can theoretically benefit through trade. Though sugar has always been a highly protected commodity the world over, the free trade spirit is also beginning to affect sugar. Along with the benefits from freer trade, however, come greater risks and greater competition. The NAFTA side agreement on sugar is described below within a general section covering the North American sweetener market. Mexico's economic restructuring is then briefly addressed separately. Both forces support the changes in the Mexican sugar industry and both appear to be long-run trends on which the industry can depend for many years.

Sugar Trade and Prospects for Mexico

International sugar trade increased in 1995/96 and 1996/97 and is expected to increase again in 1997/98 (USDA, 1996). The growing import needs of China, the United States, Russia and the Philippines are being met by increased exports from Brazil, Thailand, the European Union and Australia. As exports from Cuba have declined these countries have all increased their share of world exports in the past five years.

World sugar trade is projected at 36.2 MMT raw value, up from 35.8 MMT in 1996/97. Trade has been increasing as a share of production and should be at almost 30% for 1997/98 (USDA, 1996). Brazil is forecast to export 5.8 MMT and supersede the European

[redacted] exports > 15 MMT next year. Thailand, Australia, Cuba and [redacted] are largest exporting countries and the collection of all six exporting [redacted] 70% of world exports.

[redacted] to be the largest sugar producer in the world for 1997/98, overtaking [redacted]. This is due to a 60% increase in sugar production during the past five [redacted] result of improved varieties, increased acreage and the diversion of cane [redacted] to sugar production. Use of ethanol currently accounts for approximately 64% of sugarcane production in Brazil, though the ethanol program is scheduled for deregulation and prices may fall, causing greater diversion of sugarcane to production of sugar (USDA 1996).

Australia, which has produced record-breaking harvests for five consecutive years, is improving in part due to new technologies (such as green harvesting) and increased acreage. The success of Brazil and Australia in expanding their sugar-exporting sectors suggests two things for Mexico. First, it suggests that it is possible to build a strong export sector, and second, it suggests that the competition to be faced in a world market (e.g. Brazil, Australia) is experienced and in the midst of an expansive thrust.

If Mexico continues to produce sugar surpluses, international market channels will need to be more fully developed, so that stocks do not build unreasonably. One account reports that stocks had built up to 1.4 MMT in early 1998, or to more than one-third the size of consumption. Domestic prices will figure significantly into Mexico's exporting potential, as will the behavior of the Secretariat of Commerce and Industrial Development (SECOFI).

In most years the price of Mexican sugar has been higher than that of sugar in the world market (Figure 5 1) A few sugar price shocks in the 1970s and 1980s are reflected in Mexican prices although Mexican prices have tended to remain more stable than world prices. This suggests that SECOFI and formerly Azucar S A served two objectives in their sugar policies 1) to maintain a high level of domestic sugar supplies (and while doing so to also maintain incomes for the more than 130,000 cane growing families) and 2) to satisfy domestic demand

Current forecasts for world sugar prices predict continued low prices (11 13 cents/lb) and the current Mexican price is much higher than that This puts Mexico in a position similar to that of the United States where import restrictions are essential to maintaining a high domestic price The Mexican market is protected through a system of high variable levies on imported sugar published by SECOFI The last announcement was made on December 29 1995

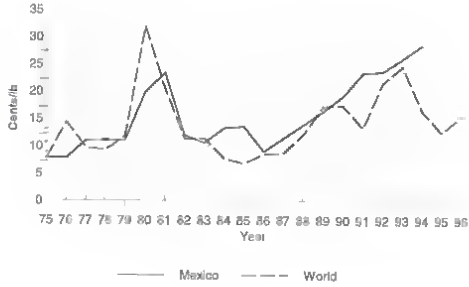


Figure 5 1 Comparison Between Mexican and World Raw Sugar Prices 1975 through 1977

SECOFI is the agency which govern[illegible] of a liberated sugar price. The importance of controlling [illegible] as will the role of access to the U.S. market. Mexico maintains [illegible] export program (TEP) through SECOFI. In fiscal year 1996 (September 1995 – August 1996) 640 000 MT were exported under TEP and eventually 180,000 MT were reimported (USDA, 1996).

For the first part of 1996 the FOB mill price was comparable to prices in the United States at approximately $0.22/lb (USDA 1996) and it fell $0.184/lb after the harvest. Some millers complained that retail prices for sugar did not change when FOB prices did and that traders gained tremendously. Because marketing channels are still being developed the role that traders play in the marketing chain as yet is undefined. Many mills sell directly to consumers and many mills are in fact consumers as a result of their links with the baking and soft drink industries.

The surpluses of sugar that the Mexican industry is generating raise several interesting questions in the context of the global sugar market. Is there sufficient economic incentive provided by the world market to continue to stimulate surpluses? Could Mexico adopt a diversified strategy such as Brazil's ethanol strategy to facilitate its development as a net exporting nation? Are the surpluses merely an incident of flat consumption driven by both freer trade and devaluation? What is the long run potential for Mexico to export sugar? Would it be more satisfactory for Mexico to import sugar and redirect resources to growing other crops? These questions cannot be considered independent of the global trend toward freer trade with GATT with NAFTA and with Mexico's policy of economic restructuring. These topics are addressed in the next subsection of this study. In particular

the NAFTA may play the critical role in determining Mexico's [illegible]
The eminent role of exchange rates inflation and prices will also be [illegible]

NAFTA and the North American Sweetener Market

NAFTA which went into effect January 1 1994 provides for the [illegible] trade barriers between the Canadian the U S and the Mexican [illegible] markets The impacts of this development on the Mexican sugar industry will start [illegible] intrinsically linked possible outcomes The first is that Mexico will gain greater access to the lucrative U.S sugar import market and in doing so find a desirable market for sugar surpluses The second possibility is that HFCS will be imported from the United States into Mexico capturing part of the existing Mexican sugar market dampening Mexico's sugar surpluses and reducing access to the U S sugar market It is also possible that some combination of the two outcomes will occur Each possibility is considered in greater detail below

A side agreement for sugar defines the extent to which Mexico will have access to the US sugar market according to NAFTA The side agreement allows for Mexico to have duty free access for net surplus production up to 25 000 tons of raw sugar during the first six years that NAFTA is in place (phase 1) and it also allows access to 250 000 metric tons between the seventh and 14th years of the agreement (phase 2) In the 15th year and beyond free trade will commence The phase 1 and phase 2 access measures only apply if Mexico can become a surplus producer of sweeteners which encompasses both sugar and HFCS consumption Corn syrup was included in the determination of net producer status in light of fears that Mexico s sizeable soft drink industry would simply substitute imported HFCS for its current sugar use thereby establishing the nation as a surplus producer of sugar

In accordance with the side agreement, Mexico [illegible] producer" only if the production of sugar is greater than the consumption of both sugar and HFCS in Mexico. If so, then Mexico will be allowed to export the amount of the surplus up to the limits mentioned above. If Mexico is not a net surplus producer, then the allowable amount of exports to the United States will be 7,258 MT. Mexico achieved net surplus producer status for 1996 and 1997, with the allowable exports at 25,000 MT to the United States for the first time. This amount represents a little more than 1% of the tariff rate import quota (TRQ) of the overall amount imported to the United States for the year.

The assessment of the "net surplus producer" status occurs annually at a meeting in July between the Foreign Agricultural Service of the U.S. Department of Agriculture (USDA) and SECOFI. Each side brings estimates of the coming fiscal year's production and consumption and the two sides decide together if the status will be achieved. There may be some debate as to the role stocks may or may not play in the long-run interpretation of the side agreement, as the side agreement is not specific on this point.

In addition, the second tier tariff on U.S. sugar imports from Mexico (about 17cents/lb) must be reduced by 15 percentage points in the first six years and then it will be reduced linearly to zero through the following years (2000/01 – 2007/08). This is a very important facet of the agreement to consider when speculating about Mexico's future access to the U.S. market.

The U.S. sugar program

The United States has always been a net importer of sugar and maintains the domestic price of sugar through a combination of price support programs and import restrictions. The price is supported via nonrecourse loans administered through the Commodity Credit

Corporation (CCC) to sugar beet and cane processors. The U.S. price for sugar [illegible] April 1996 was 22.71 cents per pound, and for refined beet sugar it was [illegible] per pound. These prices compare with world prices of 12.43 and 18.02 for raw and refined sugar respectively (USDA, 1996).

An important reason that the U.S. sugar program has maintained throughout the years is that HFCS producers and corn producers also benefit from the sugar program (Schmitz 1995). Because sugar prices are high, sweetener prices are high, and it becomes profitable to wet mill corn into HFCS. If sugar prices had been lower, it is not likely that the HFCS industry would have developed into the competitive industry that it is today. The technology behind wet milling is relatively new and would not likely have developed within a sweetener market with unsupported prices. In addition to these benefits to the HFCS market from the sugar policy, the corn market has benefitted through the expansion of demand for corn that came about with increased HFCS production.

Usually, sugar production falls below sugar consumption in the United States, and a duty free import quota is set for the amount of the anticipated shortfall. This amount is then allocated to 39 different sugar-exporting countries according to their historical participation in this market. Other sugar may be imported but with a second-tier tariff rate of roughly 17 cents/lb. Under the Uruguay Round of the General Agreement on Tariffs and Trade (GATT), the tariff rate quota must be at least 1.139 MMT. The 17 cents/lb raw value second tier tariff will also be reduced by a minimum of 15% to 14.45 cents/lb by the year 2000.

Because the U.S. prices are higher than world prices, the 39 countries which receive access to the U.S. TRQ greatly value their market share. These countries are concerned with Mexico's potential increased access (Aspin, 1997), especially since some experts believe that

with enough investment in the sugar industry Mexico could meet [illegible] demand by the year 2009 when free trade should occur (*Lunn* [illegible] 1996)

Cuba and the Caribbean producers

Prior to the 1960 Cuban trade embargo Cuba supplied approximately [illegible] U S sugar import needs (Lord 1997) Cuba continued to export sugar to the [illegible] Union through the 1970s and the 1980s but the industry lost market share and badly needed revenue when the Soviet Union broke up Both production and exports have fallen dramatically since that time and Cuba's share of world sugar exports has fallen from 20 9% in 1990/91 to 10 1% in 1996/97 Australia, on the other hand has increased production 84% since 1991 and has been able to meet the increasing sugar demands of Asia and the former Soviet Union Though at present the Cuban industry does not appear to be a strong competitor for Mexico the country is well suited for sugar production and until a few years ago produced much sugar It will probably be a considerable producer again at some point in the future (Alvarez and Castellanos 1995)

Along with the Dominican Republic the Central American countries of Guatemala and Honduras are increasing exports both to the world and U S markets While Caribbean producing countries other than Cuba are small as far as export shares go (e.g Trinidad and Tobago receive 0 7% of the tariff rate quota) cane production is quite important to several of these economies in general and to small farmers in particular

Mexico s Economic Restructuring and Macroeconomic Status

The other source of liberal trade pressure influencing the sugar industry comes from the overall economic restructuring policy in Mexico After following an import-substitution

[illegible] from the 1950s through the 1970s Mexico [illegible] large international trade debt with the major debt-[illegible] recalled sending inflation and interest rates to unprecedented high levels [illegible] stabilization (1983 through 1989) the Mexican government embarked on an export oriented industrialization (EOI) strategy The strategy involved privatization exchange rate stabilization land reform and market liberalization In the sugar industry all of these changes affect the new industry Greater details regarding these changes and the EOI are provided in Chapter 2

In 1994 once again the peso was devalued dropping from an exchange rate of 3 4 pesos/$ in mid 1994 to 7 7 pesos/$ in 1995 (Banco de Mexico 1997) During this type of a currency shock, it Is difficult to understand if Mexico or the United States has a cost advantage in production and what that advantage might be for sugar or other commodities Official statistics show that inflation was 51 97% in 1995 27 7% in 1996 and a calm 15 3% in 1997 This sums to a 223% increase in prices during the three years yet through the same period, the exchange rate only declined 10% Relatively speaking this means that the export prices producers faced were improving in Mexico throughout this period

The NAFTA side agreement on sugar has been the subject of much contention between Mexico and the United States primarily related to the increases in exports of HFCS to Mexico. In the following section this controversy is explored in greater detail and a brief history and explanation of HFCS is included

High Fructose Corn Syrup

With respect to NAFTA the recent introduction of HFCS to the Mexican market is a major development A brief history of HFCS presented below reveals a stabilizing

influence for HFCS on sugar p[illegible] for HFCS [illegible] a sweetener market suggests that expansion of HFCS is [illegible] bound with trade development. A synopsis of the anti dumping suit against U.S. production of HFCS follows to illustrate the power of trade and competition present in the sweetener market.

History of HFCS in the United States

World sugar price fluctuations in the 1970s and 1980s helped create an environment wherein HFCS technology could be developed so that corn syrup was price- competitive with sugar. Once HFCS became competitive however it captured almost one half of the U.S. sweetener market over a period of 20 years. During this time in the United States (1975 through 1995) domestic sugar consumption stayed at a fairly stable level and HFCS captured increases in sweetener demand resulting from population and income growth. From 1980 to 1995 HFCS production in the United States increased from 1.978 MMT dry basis to 7.121 MMT. Consumption of HFCS during the same period increased from 1.961 MMT to 7.0 MMT (Buzzanell, 1995).

High Fructose Syrups (HFSs) made from corn rice potatoes or wheat are manufactured and consumed in more than 30 countries though North America still accounts for 72.3% of the consumption satisfied by these syrups. While in 1985 approximately 1% of the caloric sweetener market was satisfied with HFSs the figure had increased dramatically to 8.8 by 1995 and Vuillemier (1996) speculates that by the year 2000 it will be 10.8%. He also suggests that the decreased volatility of world sugar prices is due in part to the increasing use of HFS.

Five Prerequisites for the HFCS Market

Historically if a market has possessed the five prerequisites that make HFCS an attractive substitute to sugar the industry has developed fairly rapidly (Buzzanell 1995) The five prerequisites are 1) an import status and a high internal price for sugar 2) sufficient supplies of starch 3) well developed food production and consumption infrastructure 4) capital for investment in research and development and plants and equipment, and 5) favorable government policy If these attributes exist HFCS will does not tend to substitute for all uses of sugar in a market but rather for most of the liquid sugar used Some baking uses are possible, but the largest single product for which HFCS is a favorable sugar substitute is soft drinks

Each of the five prerequisites for HFCS substitution bears closer examination in the newly created free-trade areas or customs union Import status for sugar does not exist in Mexico although the internal price of sugar has always been high When considered as one block however the free trade region (Canada, United States and Mexico) is a net sugar importing block and so in the regional sense the prerequisite is satisfied The second prerequisite is sufficient supplies of starch Once again Mexico does not regularly produce a surplus of corn or any starch, but when the NAFTA block is considered the region does produce sufficient supplies of starch as the U S corn growers produce 50% of the world corn supply and U.S consumption accounts for only 30% of world corn consumption (Buzzanell 1995)

Prerequisite number three is a well-developed food production and consumption infrastructure While the Mexican infrastructure is not as well-developed as that in the US or Canada, it is by many standards well-developed and is certainly developing rapidly Much

food is still bought and sold in t[illegible]ber and popularity. Railway and shipping [illegible] is plentiful thanks to Pemex, the federally owned oil company that owns Mexico's plentiful reserves.

Capital for investment in research and development, prerequisite number four, and plant and equipment improvement are apparently being met (again in the context of the region) as evidenced by the joint venture projects already underway (see below). The fifth prerequisite for rapid development of an HFCS market is perhaps the one least visible on the horizon. It is clear that the Mexican government does not favor imports of HFCS. On the other hand, no constraints in policy exist regarding domestic production, and the policy set in NAFTA does allow for reduced tariffs on imports.

In sum, the argument can be made that, within the regional context, at least some elements of the necessary prerequisites are in place for the development of an HFCS market in Mexico. Clearly, corn syrup producers are optimistic about the future of the Mexican market with one estimate that Mexico will be using nearly 1 MMT of corn syrup by the year 2000 (Aspin, 1997). The optimism of producers is evidenced by the approximate increase in HFCS production capacity of 30% in the United States, while the U.S. domestic market is growing at a rate of about 8% (Aspin, 1997).

The Current Controversy

In Mexico, per capita soft-drink consumption is 322 8-ounce servings per person per year, second in the world only to the United States where per person annual consumption is 343 (Vuilleumier, 1996). However, since many of the sugar mills were actually bought by soft drink bottlers, cost advantages from HFCS substitution may be pitted against the gains from vertical integration. NAFTA provides that the original Mexican 13% import tax on

HFCS will decline by 1.5% per [illegible] will be equal to zero

Total U S corn sweeteners exported to Mexico [illegible] average 57% per year between 1991 and 1996 (USDA, 1996) In 1991 11 604 MT of corn sweetener were exported, and this amount increased to 89,196 by 1996, valued at almost $40 million Overall since 1991 unit prices have tended to drop and the past two years have seen reductions in tariffs in accordance with NAFTA. The price and volume breakdown for the various types of corn sweeteners and their respective prices from 1991 through 1996 show relatively stable to declining prices in the face of growth in export volume (Table 5 1)

Table 5-1 Selected U S Sweetener Exports to Mexico and Prices

	Dextrose		HFCS-55 syrup		HFCS 55 solid		HFCS-42 syrup	
Year	Quantity MT*	Price cents/lb	Quantity MT*	Price cents/lb	Quantity MT*	Price cents/lb	Quantity MT*	Price cents/lb
1991	3019	28 2	7628	28 6	83	71 5	923	28.2
1992	3055	29 7	10256	16 9	655	16 1	6925	29 7
1993	2427	34 8	13300	16 2	139	35 1	16508	34 8
1994	7126	30 7	45251	17 8	738	31 7	21165	30 7
1995	6756	29 8	31465	19 4	7988	15 7	9488	29 8
1996	11115	24 8	47273	19 3	18607	13 0	11349	24 8

Measured in dry weight
Source USDA (1996)

In addition to the resistance that may be generated from bottlers in Mexico HFCS is currently the subject of an anti dumping investigation by the Mexican government against 17 firms for disloyal trade practices and dumping at prices below cost (Aspin 1997) The companies being investigated include most of the largest sweetener firms such as British

[redacted] Midland Cooperative Inc. The Mexican government found that the petition was viable and has placed tariffs varying from $83.75/MT or 7.6 cents per pound, to $100.6/MT or 4.57 cents/lb for HFCS grade 42 and from $55/MT or 2.5 cents per pound to $175/ton or 7.9 cents/lb for HFCS 55

At the same time, investment in wet milling of corn for production of HFCS has increased in Mexico with two joint venture projects that began production in August 1995 and mid 1996. One project is located in Guadalajara a joint venture between ALMEX (a subsidiary of Tate and Lyle) and Archer Daniels Midland Corp. The other is located in San Juan del Rio a joint venture between Mexico's largest corn wet miller ARCANIA and CPC International. Cargill currently has a plant located in Hidalgo. In addition to the 89 000 MT of HFCS imported by Mexico from the United States last year an additional 116 000 MT was estimated to be produced in Mexico totaling consumption to 205,000 MT.

On the U.S. side of the controversy many HFCS producers expanded their capacity in anticipation of the Mexican industrial market with NAFTA, and prices in the United States have now declined as excess supplies have exceeded market demand. Cargill, one of the biggest HFCS producers recently was forced to shut down one of its wet milling operations indefinitely in Dayton, Ohio.

Though the opposition to HFCS in Mexico is coming largely from sugar producers it is conceivable that Mexican sugar could gain access to the U.S. market while at the same time much of the Mexican sweetener market converts to HFCS. This can happen if Mexico continues satisfying domestic demand for sugar with a surplus that is larger than the HFCS substitution. The outcome of the controversy over the NAFTA and HFCS, the U.S. sugar

policy and Mexican [illegible] conditions will collectively [illegible] the [illegible] which Mexico will be able to maintain a profitable sugar industry with export capacity. Perhaps most important too will be the competitiveness of the sugar industry itself

CHAPTER 6
PRICE SENSITIVITY OF MEXICAN SUGAR SUPPLY

Understanding the speed of recent production increases both nationally and in the state of Veracruz is important for at least two reasons First within the NAFTA context the ability of the Mexican sugar industry to gain short run access to the US market depends on Mexico s maintenance of the status of "net surplus producer " Concern on this issue has reached serious levels as evidenced by President Zedillo s request at a recent summit meeting for President Clinton s assistance in limiting the U S exports of HFCS

The second reason for studying this rate of improvement is to understand the extent to which these improvements are motivated by market-based industry reforms and to future potential exports to the U S market through NAFTA Both of these forces suggest greater efficiency and improved production based on market signals However given the tradition of government control and social objectives favoring small producers which still persevere in the industry it is not clear that the industry would respond in the expected manner

If the market based reforms, in conjunction with the incentive provided by NAFTA, are inspiring current increases in output then a parallel hypothesis is that the industry s price sensitivity is increasing as the mills and growers move toward more profit maximizing behavior In an attempt to better understand the price signals to which producers are responding this chapter will consider the price elasticity of the national sugar supply during

[redacted] and after the [redacted] began. First [redacted] mill [redacted] I find that mill-level sugar production in the state of Veracruz fell [redacted]

Price Sensitivity

[redacted] ation of sugar supply in Mexico and the changing price sensitivity of supply will shed light both on the effectiveness of market based reforms as well as the relationship between prices and surpluses. In particular this study will estimate the price elasticity of the supply of sugar. The price elasticity of supply can be explained using the following formula:

$$\frac{\textit{percentage change in quantity of sugar supplied}}{\textit{percentage change in price of sugar}} \quad \textit{elasticity of supply}$$

Two different sets of data are used to explore this relationship. The first data set uses national averages through time to see if there is a significant change in elasticity during the years since the structural changes. The second data set looks at the state of Veracruz using mill level data for the years 1988 through 1996. Assuming there are technological innovations occurring in mills in Veracruz, the price sensitivity may help explain how much of the improvement is motivated by price increases.

The importance of price elasticity can be shown in the following set of graphs. Figure 6.1a shows the demand and supply scenarios which have come to pass in recent years. In these years (1994/95, 1995/96) the price of sugar remained under government control and was high enough to stimulate surplus production of the amount Q_s. Some of this amount probably became domestic stocks, and some was exported to the world market with typically

much lower prices. Firms then faced [illegible] with the chamber of mill owners (CNIAA) [illegible] their members. This strategy coupled with the government's [illegible] of sugar in part helped the industry to avoid the downward [illegible] existing of firms which would have been expected in a purely competitive [illegible] excess supply and a low world price. During the period between Oct[illegible] 1997 the SECOFI also agreed to temporarily subsidize exports to the [illegible] market helping sugar producers who produced a 750 000 MT surplus during the year.

In 1996 the domestic sugar price was allowed to be determined by market forces for the first time. The market responded well to the development (probably due to some cooperation among owners) and prices were maintained at previously high levels.

If domestic prices stay higher than what the market clearing prices would be surpluses should be maintained. Figure 6-1b shows a slightly more complex version of the

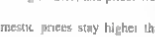


Figure 6-1a Relationship Between Price of Sugar and Quantity of Exports

Figure 6-1b Importance of Supply Elasticity in Determining Quantity of Exports

scenario which shows why elasticities are important. The inte[illegible] supply S and typically inelastic demand D with a high domestic price P_d [illegible] plus an exportable quantity Q_x. If demand shifts to D due to HFCS sub[illegible] the sugar surplus will be greater though this would not bring Mexico closer to surplus producer status as the difference would be completely offset by the increased HFCS consumption.

More importantly the diagram shows that a more elastic supply S will result in a greater surplus increase or decrease due to a price change. This is important because even if domestic prices were to remain the same in real terms (P_d), unsubsidized exports to the world market will mean that the average price a firm faces will be lower (e.g. P_x). Conversely if exports go to the U.S. market the average price a firm faces will be higher (P_d) than the domestic price. In either of these cases the elasticity of S will help explain what type of surplus will result from the price change.

The supply of sugar can be thought of as: Area (ha) * tons of sugar per hectare = tons of sugar. In this sense we can study both the elasticity of area in response to a price change and the elasticity of yield in response to a price change. The total change in supply resulting from a price change can be described by summing the two elasticities.

One of the most commonly repeated phrases within the Mexican sugar industry is that "the fields need to grow up and not out." This means that productive improvements are more desirable in the form of increases in yields—sugarcane per hectare—than in increases in hectares planted; therefore, a higher price sensitivity is expected in this arena. Borrell (1991) found yields to be responsive to six years of lagged prices, while area was only responsive to one year's prices. Devadoss, Kropf and Wahl (1995) estimated area elasticities for several major sugar producing regions and found an elasticity value of .89 to exist for Mexico—the

[illegible] India. Devadoss Kropf and Wahl used the years 1970 through 1992 in [illegible] used 1967 through 1987. A preliminary estimate of recent area response [illegible] the years 1988 through 1994 suggests a small but significant area elasticity of .04— inelastic but slightly positive as expected, and supporting the [illegible] monly held view that yield improvement rather than area improvement is the focus of the industry.

Price Sensitivity of National Sugar Yields

To emulate the Borrell's (1991) model of the Mexican sugar industry a lagged price third order Almon polynomial was estimated for the period 1981 through 1996. The dependent variable in this case is the sugar yield YD in tons per hectare. Yield is regressed on the current price P_t, and six lagged prices P_{t-1}, P_{t-2}, ... P_{t-6}, reflecting the approximate six year crop cycle. A trend variable, YR, will also be included along with a constant α. The model and parameters are shown in the following equation:

$$YD = \alpha + \beta_0 * P_t + \beta_1 * P_{t-1} + \beta_2 * P_{t-2} + \ldots + \beta_6 * P_{t-6} + \beta_7 * YR + \epsilon$$

The Almon lag assumes that the coefficients on the lagged price parameters lie on some polynomial function of degree r which is a function of the length of the lag, l. This is useful for two reasons, one theoretical and one practical. The theoretical reason is that as a cane plant grows older it produces less and less sugar biologically and this phenomenon is hoped to be captured by a function. The practical reason is that by assuming all β values result from a function of the length of the lag, degrees of freedom are preserved. Algebraically $\beta_i = f(1, i^2, i^3, \ldots i^r)$ and the parameters of f can be estimated and used to gain an estimate of the coefficients on the lagged price terms. Data for the annual production of sugar cane and

[illegible] COAAZUCAR ([illegible]) which reports the stan[illegible]ally. Prices of sugar will be supplied [illegible]l owners organizatiou *Camara Nacional de las Inhustrias Azucarera y Alcoholera*. Table 6-1 displays the results of the aggregate estimate a third order polynomial using OLS estimation as Borrell did.

The elasticity results achieved from this estimatiou are .06, .29 and .55 for current year, three year cumulative and seven year cumulative elasticities. The first elasticity reflects the response to the current year's price only. For example, if producers tend their cane with more care, apply inputs more effectively, or harvest more efficiently. Also reflected in this value is a mill level improvement or decline in efficiency respouding to the current year's prices. However such improvements/declines may well have more long term effects on yields. For this reasou, the three-year cumulative effect of prices ou yields and the seven year cumulative or long-run elasticity are computed also. This suggests that sugar yields are sensitive to price, though still inelastic. The values are similar to Borrell's who found the current year supply elasticity to be .06, the current year plus two lags to be .35, and the long-run price elasticity to be .65 for the years 1966 through 1987. Borrell's values however are complete supply elasticities, not just yield elasticities.

While this type of estimatiou may be achieved using a nonlinear estimation process, Johnston (1963) describes a method which estimates the parameters of the polynomial first, and theu substitutes back algebraically to obtain the estimates of the price coefficients. One advantage to using this method is that the order of the polynomial may be tested for directly, as opposed to assuming a particular order of polynomial. The model estimated in Table 6-1 is a third-order polynomial which was estimated using the substitution method, and from this estimation, we learn that the third-order polynomial is not necessary. A second, and

Table 6.1 Results of OLS Regression of National Sugar Yields 1981 through 1996

Independent Variable	Third-order Polynomial	Second-order Polynomial	First-order Polynomial
Constant	2.3360	2.4522	2.2568
(std. dev.)	(1.4028)	(1.397)	(1.159)
Current Year's Price	0.00045	0.00065	0.00075
(std. dev.)	(0.00049)	(0.00045)	(0.00028)
One-year Lag Price	0.00078	0.00064	0.00069
(std. dev.)	(0.00033)	(0.00030)	(0.00025)
Two-year Lag Price	0.00079	0.00062	0.00062
(std. dev.)	(0.00028)	(0.00023)	(0.00022)
Three-year Lag Price	0.00061	0.00057	0.00056
(std. dev.)	(0.00020)	(0.00020)	(0.00020)
Four-year Lag Price	0.00041	0.00050	0.00050
(std. dev.)	(0.00021)	(0.00019)	(0.00018)
Five-year Lag Price	0.00032	0.00042	0.00044
(std. dev.)	(0.00023)	(0.00021)	(0.00018)
Six-year Lag Price	0.00050	0.00031	0.00038
(std. dev.)	(0.00036)	(0.00031)	(0.00018)
Trend	0.11436	0.11339	0.1122
	(0.01405)	(0.0219)	(0.0206)
Adjusted R^2	0.8244	0.8246	0.8381
1-year Elasticity	0.064	0.0937	0.1072
	(.0713)	(0.0713)	(0.0409)
3-year Elasticity	0.288	0.2749	0.2956
	(0.1348)	(0.1340)	(0.1070)
Full Price Elasticity	0.553	0.5357	0.5680
	(0.235)	(0.2342)	(0.1951)

[illegible] timated using the same data, and the results are also [illegible] in Table 6 1

In the case of the third order polynomial none of the parameters on the Almon lag [illegible] are significant at any conventional confidence interval In the second order [illegible] of the polynomial coefficient for the prices themselves is significant at the 82% [illegible] dence level, and neither the coefficient for a first order polynomial nor a second-order [illegible] nomial is significant The first-order polynomial estimation however shows that the coefficient for the prices is significant at the 98% confidence level and that the coefficient for the price multiplied times the length of the lag is significant at the 75% confidence level The first order polynomial model also displays the highest adjusted R with a value of 8381 with the values 8246 and 8244 for the previous two models respectively The polynomial specification represented by the first order model is as follows

$$YD = \alpha + \gamma_1(P_{t-1} + P_{t-2} + P_{t-3} \ldots + P_{t-8}) + \gamma_2(P_{t-1} + 2Pt\ 2 + 3P_{t-3} \ldots 9P_{t-9}) + \beta_1 + YR$$

and substituting for price coefficients $B = \gamma_1 + \gamma_2$ *where* $0 < i > 7$

The estimates of supply price elasticity obtained from the first-order model are 107 for the first year elasticity 2956 for the first year plus the first two years of lagged prices and 5680 for the price long-run price elasticity The estimates were calculated at the mean values of price and yield. These estimates suggest that the supply of sugar is very price inelastic in both the short and long run and the results for the one year and three year elasticities are more elastic than those obtained by Borrell for the period from 1966 through 1987 The trend coefficient is estimated at a value of 114 reflecting an annual increase of about 114

kilograms of cane per hectare This trend [illegible] reflects the [illegible] improve[illegible] to technological advancement.

Table 6-2 displays the results for the [illegible] models for the period 1988 through 1996 This begins with the year that the government began to sell the sugar mills back to private buyers and the movement toward market based restructuring was beginning The three models for the recent time series also assume respectively a third-order second-order and first-order polynomial lag structure Similar to the estimations for the longer time period the first two models fail to reject the null hypothesis of the absence of third-order and second order elements in the polynomial structure The first order polynomial structure however rejects the null hypothesis of absence of the structure and allows for more degrees of freedom in the model since the higher-order parameters need not be estimated. The R value is also the highest for this model at 7876 over the values of 6652 for the third order polynomial and 7489 for the second order polynomial

The trend variable suggests an annual decline in sugar production of approximately 460 kilograms This is unexpected as technological improvement is generally credited with increasing yields Declines in yields certainly have occurred from year to year at least once at every mill through the period and so the negative trend is not completely infeasible However the estimate is not significant and probably is more indicative of the erratic recent history the industry endured during the privatization process The negative trend does not mean that improvements have not tended to be positive. It does suggest however that improvements have been motivated more by prices than independent of prices The result may also reflect the closing of the national sugarcane research center (IMPA) in 1990

Table 6-2 Results of OLS Regression of National Sugar Yields 1988 through 1996

Independent Variable	Third-order Polynomial	Second-order Polynomial	First-order Polynomial
Constant (std. dev.)	10.1412 (13.7727)	10.3307 (9.2627)	11.85 (8.0038)
Current Year's Price (std. dev.)	0.0038 (0.0028)	0.0038 (0.0023)	0.0044 (0.0019)
One-year Lag Price (std. dev.)	0.0036 ()	0.00365 (0.0020)	0.0040 (0.0017)
Two-year Lag Price (std. dev.)	0.0034 (0.0031)	0.00342 (0.0018)	0.0036 (0.0016)
Three-year Lag Price (std. dev.)	0.0031 (0.0024)	0.0031 (0.0016)	0.0033 (0.0015)
Four year Lag Price (std. dev.)	0.0022 (0.0018)	0.0027 (0.0014)	0.0029 (0.0013)
Five-year Lag Price (std. dev.)	0.0023 (0.0017)	0.0023 (0.0014)	0.0025 (0.0012)
Six-year Lag Price (std. dev.)	0.0017 (0.0030)	0.0017 (0.0014)	0.0027 (0.0011)
Trend	0.4097 (0.5095)	-0.4167 (0.7489)	-0.4597 (0.3043)
Adjusted R^2	0.6652	0.7489	0.7876
1-year Elasticity	0.528 (0.3826)	0.523 (0.3219)	0.597 (0.2594)
3-year Elasticity	1.483 (1.2146)	1.499 (0.8301)	1.640 (0.7204)
Full Price Elasticity	2.834 (2.384)	2.867 (1.594)	3.121 (1.383)

The elasticity estimates for the recent period suggest that sugar [illegible] much more price responsive than for the period including the previous seven years. The value of .597 for the price elasticity for the current price is still considered inelastic because it is less than unity but it is nearly six times as large as that of the longer time series estimates in Table 6.1. The three year lag price elasticity is estimated at a value of 1.640 which is considered elastic and the long run price elasticity is estimated at 3.121 which is also elastic. The long-run price elasticity signifies the percentage increase in yields that a 1% increase price would cause when the yield increase is summed over the full seven years that the price is hypothesized to effect output.

A t-test can be used to test whether or not the difference in the elasticity estimates between the first time series and the second is significant. The result of the test is that the null hypothesis of no difference between the pairs of one year, three-year and long run elasticities between the full and the recent data sets is rejected in all cases. The z statistics are 5.6, 5.564 and 5.507, respectively, for the three elasticities.

Price Sensitivity of Sugar Yields in the State of Veracruz

The 21 different sugar mills operating in the state of Veracruz cover a diverse collection of land types, soil types and irrigation availability combinations (see Chapter 3). The mills themselves also vary in age, size and recovery rates. These differences are reflected in differences in yields throughout the state which range from a low of 2.57 tons of sugar per hectare, to a high of 13.30. Using a same lagged price structure as the one used in the previous section, the question of supply price responsiveness for the state of Veracruz is addressed in a cross sectional time series framework considering mill level data on yields for the period from 1987 through 1996. First, a model employing a dummy variable for each

mill is estimated [illegible] All the lagged price structure is assumed to be uniform across the mills. Next the mills are grouped according to similarities in yields. A trend variable is used to reflect high-end technological improvement that should describe the rate of improvement occurring at the production frontier.

Table 6.3 shows the results from estimating the following equation

$$YD_{i,t} = \alpha + \beta_0 * P_{i,t} + \beta_1 * P_{i,t-1} + \beta_2 * P_{i,t-2} + \beta_3 * P_{i,t-3} + \beta_4 * P_{i,t-4} + \beta_5 * P_{i,t-5} + \beta_6 * P_{i,t-6} + \beta_7 * YR + \sum_{k=1}^{21} \beta_{7+k} * \delta_k + \varepsilon$$

$$\text{where } \delta_k = \begin{cases} 1 & \text{if } k = k \\ 0 & \text{if } k \neq k \end{cases}$$

To prevent the collection of dummy variables from being a linear combination of the constant, the mill with the lowest average annual yield for the time period is used as the basis for the estimation, and the dummy variables can be thought of as shifting the equation beyond the lowest-yielding mill.

The results shown portray an Almon first-order polynomial lag. The estimation succeeded in rejecting the null hypothesis that the coefficient on the second-order polynomial was equal to zero with confidence level of 99.7 %. The trend variable is equal to a trend representing each year for the observations from the mills with the highest yields. The rationale behind this was that many of the mills changed hands and experienced erratic movements of yields due to managerial trouble during this period. At the same time, the more stable mills were making technological improvements which may eventually be adopted by the others. The rate of improvement is therefore more accurately captured by modeling the rate of improvement at the innovative mills.

Table 6.3 Parameter Estimates from Second order Polynomial Model with Mill Dummy Variables

Parameter Estimate	Estimate	Standard Deviation
Intercept	-1.577	0.8920
Current Price	0.00077	0.00032
First Lagged Price	0.00119	0.00017
Second Lagged Price	0.00139	0.00014
Third Lagged Price	0.00138	0.00015
Fourth Lagged Price	0.00114	0.00015
Fifth Lagged Price	0.00068	0.00017
Sixth Lagged Price	0.0000025	0.00070
Mill 1 Dummy	1.1635	0.3689
Mill 2 Dummy	2.0279	0.3756
Mill 3 Dummy	4.4087	0.4827
Mill 4 Dummy	1.3115	0.3707
Mill 5 Dummy	6.915	0.4106
Mill 6 Dummy	4.345	0.3664
Mill 7 Dummy	0.763	0.4334
Mill 8 Dummy	5.596	0.4817
Mill 9 Dummy	6.143	0.4647
Mill 10 Dummy	1.835	0.3583
Mill 11 Dummy	5.243	0.5525
Mill 12 Dummy	1.767	0.3289
Mill 13 Dummy	1.2004	0.2886
Mill 14 Dummy	1.961	0.4053
Mill 15 Dummy	1.823	0.4221
Mill 16 Dummy	3.602	0.4498
Mill 17 Dummy	5.062	0.4509

Table 6 3 Continued

Parameter Estimate	Estimate	Standard Deviation
Mill 19 Dummy	1 907	0 3525
Mill 20 Dummy	2 9133	0 3206
Mill 21 Dummy	2 0316	0 3839
High-end Trend	0 0342	0 0467
R^2	8445	
Elasticity—current price	0 10268	0 0423
Elasticity—current + 2 lags	0 4481	0 0713
Elasticity—long run	0 8755	0 00095

In an effort to pool the mills according to similar yield capacities nine different dummy variables were used Table 6-4 shows how the mills were grouped and the F test statistic for a hypothesis test for differences in the dummy variables

The results from the same type of Almon lagged regression are presented in Table 6 5 The first column shows the results estimated for the first-order polynomial and then the second order polynomial rejects the null hypothesis that it is equal to zero with 99% confidence The adjusted R^2 value also improves between the first-order and second-order polynomial lags from .8449 to .8515 It is noticeable that both high-end trend coefficients are negative very close in magnitude and neither is significant This could be explained by the fact that the period of analysis has been primarily marked by transition and sugar production has been somewhat unstable though overall yields have been steadily increasing, but are less elastic than those estimated for the nationwide aggregates during the most recent nine years The second order polynomial elasticity estimates were also very similar to those estimated with the second-order polynomial using a dummy variable for each and every mill (Table 6-3)

Table 6-4 Grouping of Mills for Regression Purposes

Grouping	Pooled mills	Mean Yield	Standard Deviation	Prob > F
One	1 4 7 13	5 43	910	6439
Two	2 10 12 14 15 19 21	6.25	968	9859
Three	3 6	8 62	1 33	8771
Four	8 11 17	9 49	905	.5536
Five	20	7 28	1 33	
Six	16	7 83	697	
Seven	9	10 36	1 37	
Eight	5	11 12	1 44	
Nine	18	6 57	534	

Table 6-5 Estimation of Venezuz Sugar Yield Model 1987 through 1996

Parameter Estimated	Hitrend—1st-order	Hitrend—2nd-order
Intercept	2 6935	1 6034
(standard deviation)	0 8115	0 8709
Current Price	0 00154	0 00078
(standard deviation)	0 00018	0 00031
First Lagged Price	0 00140	0 00120
(standard deviation)	0 00015	0 00016
Second Lagged Price	0 00125	0 00140
(standard deviation)	0 00013	0 00014
Third Lagged Price	0 00110	0 00139
(standard deviation)	0 00012	0 00015
Fourth Lagged Price	0 00096	0 00114
(standard deviation)	0 00014	0 00014
Fifth Lagged Price	0 00082	0 00068
(standard deviation)	0 00016	0 00016
Sixth Lagged Price	0 00068	0 00000018
(standard deviation)	0 00020	0 00030

Table 6 5 Continued

Parameter Estimated	Hitrend—1st-order	Hitrend—2nd-order
Group 1 Dummy	1 168	1 172
(standard deviation)	0 275	0 270
Group 2 Dummy	1 889	1 892
(standard deviation)	0 274	0 268
Group 3 Dummy	4 376	4 368
(standard deviation)	0 357	0 349
Group 4 Dummy	5 294	5 291
(standard deviation)	0 379	0.371
Group 5 Dummy	2 914	2 913
(standard deviation)	0 320	0.313
Group 6 Dummy	3 615	3 611
(standard deviation)	0 449	0 439
Group 7 Dummy	6 153	6 153
(standard deviation)	0 464	0 454
Group 8 Dummy	6.933	6 925
(standard deviation)	0 4100	0 401
Group 9 dummy	2 205	2 205
(Standard deviation)	427	(417)
High-end trend	-0 036	-0 0336
(standard deviation)	0 046	0 0456
R^2 adjusted	8449	8515
Elasticity—current price	0 2054	0 1042
(standard deviation)	0 0250	0 0413
Elasticity—current + 2 lags	0 5590	0 4517
(standard deviation)	0 0614	0 0696
Elasticity—long run	1 0372	0 8793
(standard deviation)	0 1149	0 1258

The results from the [illegible] analysis of the Veracruz industry suggest that real [illegible] yields significantly in the expected fashion especially when taking into [illegible] on the long ration period Though technological advancement is improving yields [illegible] fails to capture this relationship independent of the price effect

Conclusions

Three general conclusions can be drawn from the regression analysis and elasticity [illegible] First that improvements in production of sugar are significantly related to prices as expected in the years since the structural changes in the industry Second price sensitivity moves in both directions, and unsubsidized exports to the world market may likely bring about price declines and with the price declines production declines Finally all other things the same reductions in supply which could occur from price declines would decrease the probability that Mexico maintains the status of surplus producer in the coming few years

It should be remembered that these elasticity estimates are for yield only and an estimate of total supply elasticity would be the sum of the area elasticity and the yield elasticity As Devadoss Kropf and Wahl (1995) estimated an area elasticity of .89 that value might be added to these elasticities for a total supply elasticity however his estimates were not for the same sample period Furthermore this study has not been able to discover a significant relationship between area planted and price, so it is also possible that the price effect is primarily demonstrated in yield enhancement

CHAPTER 7
THE NORTH AMERICAN SWEETENER MARKET

Mexico s sugar industry is in a critical period of transition Within the framework of the existing policy and trading schemes two alternative end results are possible 1) The North American sweetener market will converge in the near future, with free movement of high fructose corn syrup (HFCS) and sugar across the U S Mexican border but with the region as a whole still protected from unrestricted imports of sugar 2) Mexico will become an importer of sweeteners importing HFCS from the United States and possibly sugar from the world market In the former scenario, according to NAFTA Mexico would still need to export an amount of sugar equal to Mexico s consumption of HFCS to the world market In other words the Mexican sugar surplus would need to be maintained at a fairly high level for at least the next 10 years. The latter scenario might come about if the Mexican sugar industry suffers immediate losses of domestic market share to HFCS without being able to export a substantial portion of its sugar surplus to the lucrative U S market The end results will depend upon the size of Mexico s sugar surpluses which in turn depends on sugar production and consumption which both depend in part on the price of Mexican sugar

Chapters 4 and 5 dealt with the possibilities of increased sugar exports for Mexico in terms of the ramifications within the national system (Chapter 4) and in terms of the sweetener trade outside the national boundaries (Chapter 5) This chapter addresses the various price policy considerations and options facing the Mexican industry A graphical

representation of these considerations illustrates a producer pricing problem with the intent to answer the question "Does an optimal price exist to maximize the probability of sustaining net surplus producer status?"

Hypothetical Situation

With the newly liberated price of sugar the Mexican government and the sugar industry are faced with an interesting collection of options One option is to allow the price of sugar to move to the domestic competitive equilibrium price which is probably higher than the world price but possibly lower than the current price. This option however is not likely to generate any sugar surpluses for export The advantages to this would be that supply and demand would be in equilibrium and no sugar would be sold at world prices which are assumed to be lower The disadvantage would be that no sugar would be sold at U S prices which are assumed to be higher Further disadvantages are that the competitive equilibrium may involve industry contraction especially as market share is lost to HFCS

Alternatively supporting the price at above the competitive equilibrium price provides the advantage of increased producer profits for the quantity sold domestically increased production, which serves employment goals and an increase in the size of sugar surpluses which increases the chances of being able to access the U S market. Disadvantages to this policy are that some of the quantity will be sold at lower (world) prices and that a higher domestic price for sugar makes the lower-priced HFCS substitute more attractive This in turn increases the quantity of exports of sugar to the world market required for Mexico to achieve surplus producer" status and in this sense decreases the chances of being able to access the U S market

These two scenarios can be compared (see Figure 7 1a and 7 1b) The supply of sugar is assumed to be an upward-sloping function of the price of sugar and the demand for sugar is assumed to be a downward sloping function The inverse demand and supply functions are shown in the figures The market is in equilibrium when the quantity demanded (Q_m) is equal to the quantity supplied (Q_s) and the resulting equilibrium price and quantities are attained (P_e and Q_e) If the price is supported at a level higher than P_e say at P_m (Figure 7 1b) then producers gain an amount equivalent to the difference between the equilibrium prices and the support price for the amount demanded at price P_m (Q_m) At this point the quantity supplied is Q_s and the surplus quantity is exported to the world market and sold at price P_w In this case producers would gain in the amount equivalent to the price increase ($P_m - P_e$) times the amount they sell in Mexico (Q_m) and producers will lose the area under the supply curve and above the world price P_w If the gains outweigh the losses it will

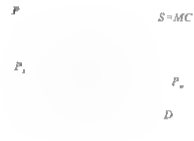


Figure 7 1a Competitive Equilibrium Price and Quantity in Mexican Sugar Market

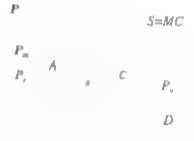


Figure 7 1b Support Price P_m Results in Net Producer Gain – A B C

enhance producers profits to support the price If not, the competitive equilibrium will be optimal for producers In the diagram (Figure 7 1b) net producer gain is shown as the area A B C

Mexican Producer Problem

The example above is not a realistic expression of the Mexican producer problem for several reasons First and foremost the price of sugar in Mexico is now determined by market forces, and though the government is still controlling imports this mechanism alone is not sufficient to maintain a support price when surpluses exist. Consequently the question of supporting domestic price is not really being asked Second, due to the cane pricing legislation enacted in March 1997, supplies of cane are not solely dependent upon domestic prices but on a price which will be the weighted average of the domestic price and world price.

This weighted average price can also be thought of as the average price firms face In general, by internal agreements within the chamber of mill owners, the exports are shared equally across all producers and then the weighted average price is shared by all

Respecting the two features mentioned above, a version of the Mexican producers problem is presented below This version assumes that producers can collude and keep prices higher than competitive equilibrium prices though they cannot control output. Output is assumed to respond to the weighted average price which is used as a base price with which to pay the growers Sugar producers must pay cane growers 57% of the price of sugar for the amount of sugar recoverable from one ton of sugarcane Hence the supply of sugar is assumed to follow directly from the sugarcane supply which responds to the weighted average price of sugar

The assumption that producers collude and set domestic prices is acceptable for two reasons. It is acceptable because producers do communicate and try to set practices that benefit all within the context of the chamber of mill owners. However, the existence of the largest consortium places doubts on the ability of the organization to enforce any agreements they reach. Secondly, the assumption is acceptable for the purpose at hand, which is to develop a framework within which to examine the academic question of whether or not a pricing strategy exists that could lead Mexico toward achievement of surplus producer status.

Given the assumption that producers can choose domestic price but not the level of output, we can think of the industry as a price-maker. In a monopoly, the producer selects the optimal price and quantity by setting his or her marginal revenue (MR) equal to marginal cost to determine quantity and then looks to the demand curve to determine the price at said quantity. The marginal revenue is a downward-sloping function that lies underneath the demand curve. This is because, for each additional unit sold at a slightly lower price, the monopolist gains the additional sale but also loses the difference between the old and new price for the entire quantity previously sold. Consequently, the additional or marginal revenue for selling an additional unit of quantity is the additional revenue, minus the incremental price lost on each of the units previously sold.

In the price-maker model representing the sugar industry, the optimal price and quantity for the domestic market can be found at the point where the marginal revenue in the domestic market just meets the world price. Further sales in the domestic market will provide returns that are less than those of the world market and that therefore would be better exported. Similar to the monopolist, the sugar industry could act as a price maker, setting the price equal to the price on the demand curve corresponding to the equilibrium quantity (see

Figure 7 2a) The excess supply will be the difference between the quantity consumed (Q_m) at the domestic price (P_m) and the quantity supplied at the weighted average price ($\bar{P}^*$). Still depending on the slope of the marginal revenue curve (which depends on the slope of the demand curve) at least two outcomes are possible. The first outcome is as described above with exports (Figure 7 2a). The second possible outcome is that no exports exist, and the competitive market equilibrium will prevail (Figure 7-2b). This situation can arise if at the competitive equilibrium quantity the marginal revenue is still higher than the world price.

It is important to notice that under this scenario the pricing strategy has little to do with the supply curve. The important determining factors here are the demand curve that will determine marginal revenue and the world price. The supply curve only becomes important in determining the equilibrium quantity in the case where the competitive equilibrium quantity is less than the quantity corresponding to the intersection of marginal revenue and

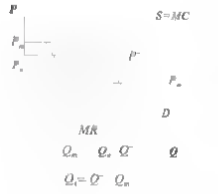


Figure 7 2a Stylized Price Support with Domestic price $\bar{P}_m$ and Exports of Quantity Q

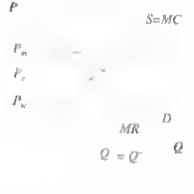


Figure 7 2b Stylized Price Support Model with no Exports because MR at Q_c is Greater than the world price $\bar{P}_w$

the world price (Figure 7.2b). Furthermore, if the supply curve shifts to the right (as we may assume it is currently doing with increases in productivity), the expected result based on this model is that the quantity of exports will increase.

A simplified algebraic example is provided here. Suppose the inverse demand function is specified by the equation $P_m = a_0 + a\,Q_m$. Then the marginal revenue is specified as $a_0+2a_1Q_m$. By setting the MR curve equal to P_w and then simplifying, we see that

$$Q_m = \frac{a_0 - P_w}{2a_1} \text{ or } Q_e \text{ whichever is less and}$$

$$P_m = \frac{a_0+P_w}{2} \text{ or } P_e \text{ whichever is greater}$$

The formula for finding Q_e and P_e is as follows, assuming that the inverse supply is some linear supply function specified as $P_e = b_0+b_1Q_e$ and setting P_e equal to P_d.

$$P_e = a_0 - a_1Q_e = b_0 + b_1Q_e$$

$$\Rightarrow Q_e = \frac{a_0 - b_0}{a_1 + b_1}$$

and

$$Q_e = \frac{P_e - b_0}{b_1} = \frac{a_0 - P_e}{a_1}$$

$$\Rightarrow P_e = \frac{a_0b_1 + b_0a_1}{a_1 + b_1}$$

Solving for the "no export" case, when $Q_m=Q_e$, we can obtain the conditions for such a case.

$$Q_m = Q_e$$

$$\frac{a_0 - b_0}{a_1 + b_1} = \frac{a_0 - P_w}{2a_1}$$

Or solving for the condition that the world price be equal to

$$P_w = \frac{2a_1b_0\ b_1a_0 - a_1a}{a + b}$$

if P_w is greater than the value of the term on the right-hand side of the equation exports will be desirable. Similarly we could solve for the condition in terms of the slope of the demand curve when no exports are desirable

$$a = \frac{b_1(a_0 - P_w)}{a_0 - 2b_1 + P_w}$$

In this case, if the value of a (the slope of the demand curve) is greater than the phrase on the right hand side of the equation then exports will exist.

Assuming that the condition is met and that exports exist a geometric example will assist in understanding the size of producer gains. First we are reminded of the definition of P^*

$$P^* = \frac{(Q_m * P_m) + (Q_x * P_w)}{Q} \text{ and therefore}$$

$$Q = \frac{(Q_m * P_m) + (Q_x * P_w)}{P}$$

Using this definition and rearranging we can see that an identity exists which represents certain areas in the graph in Figure 7 2a.

$$PQ\ \ Q\ \ P_m\ \ (Q\ \ Q_m)P$$

$$n\ \ (\bar{P}\ \ P\ )Q\ \ (P_m\ \ \bar{P}\ )Q_m$$

Redrawing Figure 7 2a with a little less detail the identity can be seen as the identity between the following areas A+B+C=B+C+D+E+F+G+H in Figure 7 3 Canceling area B+C from both sides we see that A=D+E+F+G+H Producer gains from moving from the competitive equilibrium to a price floor at P_m will be equal to area A+B-(E+G+H) Substituting D+E+F+G+H for A producer gains equal area B+D+F This makes sense when realizing that $\bar{P}$ is the average price that producers now receive

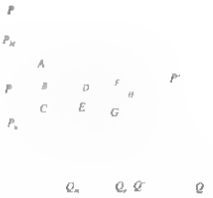


Figure 7 3 Producer Gains from Moving from Q to Q_m are Equal to B + D + F

Including NAFTA and HFCS

The problem now becomes slightly more complicated when NAFTA and HFCS are taken into consideration Returning to the solution depicted in Figure 7 2a, two strategies might be considered in order to gain access to the U S market The criterion required to gain

access is that surplus sugar exceed HFCS consumption Assuming again that producers can control domestic price but that they do not control domestic output, several possibilities arise

In the previous solution the value of P^* (or the average revenue received by the firm) can only decline as output increases past the optimal point because as output increases it will be exported to the world market and P^* will approach P_w By including the NAFTA option the equality describing P^* becomes

$$P^*Q = P_m Q_m + P_w Q_w + P_{us} Q_{us}$$

where Q_w is now the amount of exports to the world market and not total exports As output increases P^* will approach P_w and at the point where "net surplus producer" status is achieved P^* will increase again as output increases to satisfy the NAFTA quota. If the optimal solution in Figure 7 2a satisfies the net surplus producer condition then the solution will be the same for the NAFTA case If not producers must consider whether gains from revenue in the U S market are larger than losses from moving away from the optimal price strategy described above

Two cases are considered First the net surplus producer criterion could be met by attempting to increase the quantity of exports by raising P_m Alternatively the criterion might be met by decreasing the quantity of HFCS consumed via lowering the domestic price of sugar to compete more with HFCS The price raising strategy is graphically shown in Figure 7-4

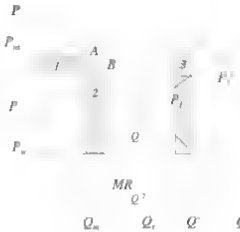


Figure 7-4 Producer Gains from Price Raising Strategy Moving from price B to A Would be Equal to 1 2 + 3

The figure illustrates the manner in which producer gains change when moving from the original solution to the proposed price raising NAFTA solution

In order for this solution to be preferable, several conditions must hold. First demand must be inelastic If demand is inelastic then an increase in P_{us} will increase the revenue realized in the domestic market and will increase the portion of total output that is exported The other condition that must hold is that this increase in Q_s must be great enough not only to exceed former HFCS consumption but also to compensate for the increase in HFCS consumption that was stimulated by the increase in the price of sugar Hence if the cross price effect of a change in sugar price on HFCS demand in Mexico is greater than the decrease in sugar demand resulting from the increased price plus the supply response

corresponding to the change in P" then all is for nnught In this case, expanded access to the U S market will not occur and the previous solution will hold.

The other strategy is to lower the price of sugar domestically in Mexico in hopes of recapturing some of the HFCS market and thereby reducing the size of the surplus needed to access the U S market This scenario is shown in Figure 7 5 Using this strategy, the producer gains are equal to area 2+3 1 This strategy will be effective under a different set of conditions First, an elastic demand for sugar will result in the largest value of area 2 1 Area 2 may still be smaller than area 1 but as long as the value of area 2 1 is as large as possible, the chance for success of the strategy is better An elastic demand will result in decreasing values of area 2 1 as P_m decreases Ideally under this scenario the cross price effect of a change in the price of sugar on demand for HFCS would more than compensate in decreased quantity of HFCS consumption for the decreased size of the surplus caused by the same sugar price decrease In this way the strategy also decreases the size of the surplus required to achieve surplus producer status and to access the U.S market

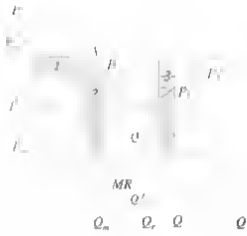


Figure 7 5 Producer Gains from Price Lowering Strategy Moving from Price A to B Would be Equal to 2 + 3 -1

Summary

Several points about the potential for trade and the optimal condition pricing strategies in Mexico can be drawn from the price-maker model Exports will to be a good strategy for Mexico from the producers point of view as long as the marginal revenue for the industry as a whole in Mexico lies below the world price at the competitive equilibrium quantity The optimal domestic price will be the price on the demand curve that corresponds to the quantity at the point where the marginal revenue equals the world price of sugar In a closed economy competitive system, this condition would eventually be corrected until no more profits were to be had in the industry But if imports are restricted and exports are unrestricted the potential to continue increasing output is strong as there are no declining marginal returns after this point If the marginal revenue is above the world

price at the quantity corresponding to the competitive equilibrium then the industry is [illegible] off at the competitive equilibrium price and quantity

Accessing the U S market can be viewed as a more complicated producer pricing problem, which requires knowledge of both domestic demand for sugar and domestic demand for HFCS In the case where sugar demand is inelastic and the cross price effect of HFCS is not strong a price raising strategy will improve the ability to access the U S market (that is achieve "surplus producer status") If both the cross price effect of HFCS demand is strong and own-price elasticity of sugar is elastic a price lowering strategy will improve the access potential It should be remembered that while demand for sugar is often thought of as typically inelastic, the presence of a viable substitute (HFCS) alters this expectation A combination of elastic demand for sugar and weak cross price effect for HFCS or of inelastic demand for sugar and strong cross price effect for HFCS will require calculation to determine the most favorable strategy

CHAPTER 8
RESULTS AND CONCLUSIONS

A complex system of institutional technological and economic relationships have been described in this study Together these relationships are functioning in a manner that is new to the Mexican sugar industry and yet consistent with economic theory Competition for profits among private firms inspires new technologies Fluctuating prices are allowed to reflect producer and consumer decisions and preferences Elimination of market interference improves efficiency and internalizing the market externalities improves allocative efficiencies Simultaneously outside forces are presenting challenges to the industry Different challenges arise to the growers in the context of a mill to mills in the context of the privatization of mills and to the national industry in the context of the North American sweetener market. It has been the goal of this study to analyze these various transitions in the Mexican sugar industry primarily with two questions in mind. 1) What are the primary sources of the increases in sugar production of the previous three harvests? (Part I) and 2) What significance do the increases have with respect to NAFTA and the North American sweetener market? (Part II)

Balance of Old and New

The first question regarding the sources of increased production was addressed in Chapters 2, 3 and 4 (Part I) An historical analysis of the current set of industry transactions

showed that modern competitive economic forces are coexisting in the industry with some traditional political goals. Governmental support for small farmers has been a tradition in the sugar industry for many years and remains to a certain extent in the new industry in the form of financing, union support and supervision of the cane payment process. In those instances during which government support for small farmers was interfering with the market, these elements are being eliminated. For example, where land tenure law previously restricted land use, these laws have been reformed toward more clearly defined property rights that are essential for a well functioning free-market system. Also, the linkage of social security benefits for growers, which still attracts people into sugar production for reasons unrelated to profits, is being internalized. This incorporation of an external benefit should soon bring about additional efficiency within the industry.

Land Concentration

The question of land concentration was raised in Chapter 2, and two points are emphasized. First, that production has increased and productivity has improved without a decrease in the size of the average sugarcane farm. For this reason, land concentration—at least in the technical sense of increasing average farm size—is apparently not essential for productivity enhancement.

The second point is that the benefits of land concentration may be occurring in several other forms. While farm ownership may not change, the increasing incidence of land rental suggests that more acreage will be farmed together as a unit. Also, increased emphasis on the use of harvesting groups encourages coordinated farming. Finally, given the fact that

[illegible] regarding input use, cultival[illegible] technology occurs at the mill level. It may be that the appropriate unit of produ[illegible] mill.

None of these arguments deny the fact that the [illegible] is required to coordinate the great numbers of small producers in the[illegible]. Yet [illegible] there fewer land owners and still just as many workers, some administrat[illegible] would [illegible] be required. Furthermore the administrative programs—which are familiar and [illegible] somewhat traditional—do not present any increase in costs to the present system. It must be remembered that the production system studied was within the state of Veracruz. While the largest sugar-producing state, Veracruz contains production systems particular to the social, technological and economic conditions within the state, and production in other states may be experiencing trends quite different from that in Veracruz.

Sources of Productivity Improvement

A closer examination of sugar mills and recent developments in sugar production in the mills of Veracruz (Chapter 3) leads to several conclusions about the sources of improved production. Improved varieties, improved harvesting strategies, and location specific technological innovations are the primary sources of efficiency improvement. These changes are beginning to show up in improved efficiency measures, such as yields and factory recovery rates. It is possible that these measures will continue to improve for some time as a result of the innovations and structural changes. Whether in the form of mill-specific innovations or much larger trends, such as the worldwide trend toward green-harvesting, the potential for technological innovation to continue to bring about improvements in overall sugar per hectare should not be overlooked.

Another important point is that there exists heterogeneity among the mills in Veracruz. With the investment in and continued success of better run mills it is possible that the less efficient mills will close and most likely will be bought by the more successful firms thereby further concentrating the industry at the processing level

Systems Analysis

Through the past decade the restructuring of Mexico's economy coupled with the NAFTA and the peso devaluation has made it difficult to understand and isolate the effects of particular developments within the sugar industry A systems diagram was developed (Chapter 4) as a cognitive tool to help convey the level of complexity within the system As a working policy management tool further validation and revision would be appropriate and necessary though, at present it can be used to generate ideas For example the role exports will play within the system remains unclear although the linkages to HFCS consumption, yields and macroeconomic policy are fairly well-defined

Overall conclusions from this part of the analysis underscore a theme of efficiency The three focal points of the system are growers mills and sugar yields reflecting three types of efficiency improvements necessary for successful progress in the industry social economic and technical efficiency It must be remembered that the priority placed on growers, grower households and income is an important component of the system Analysis of pressure on households does suggest that marginally productive sugar lands will move out of the system The role of government will continue to decline

North American Sweetener Market

The second question motivating this study moves from analyzing components within the national system to analyzing the national system within the North American sweetener market. In Chapter 5 the sweetener market is analyzed and the role of HFCS is considered in the regional context. The trends toward freer trade both globally and within the North American market bring about increased pressure for the Mexican industry to become competitive. If the region continues to operate with restrictions on sweetener imports it will effectively insulate itself from the competitive forces of the global market, which might include competition from efficient sugar producing nations such as Brazil. Also HFS production is on the rise globally. Policy uncertainty surrounds much of the future for sweeteners both in North America and globally. At present in the NAFTA context, the most important question for determining Mexico's potential to achieve surplus producer status is whether the surplus production of sugar will exceed HFCS consumption in Mexico. More dynamically can surpluses of sugar continue to exceed HFCS consumption in Mexico and for how long?

Yield Elasticities

The sources of sugar surpluses were individually explored in Part I. As an overall measure of the effects of industry restructuring, sugar yield elasticities were estimated for Veracruz, and for the nation as a whole, to explore the price responsiveness of the new sugar industry and thereby better understand the role of Mexican sugar prices in determining the size of surpluses (Chapter 6). Results suggest that yields have become more sensitive to price in recent years. Borrell estimated elasticity of supply using a six year price lagged model and

found elasticity estimates of .06 .35 and .65 for one year three year and six year lagged responses, respectively during the period 1967 through 1987. The estimates derived herein for the nation using a similar model were .12 .30 and .57 for yield alone during the 1981 through 1996 period. These estimates would need to be summed with an acreage elasticity to achieve a complete estimate of supply elasticity though no significant relationship between acreage and price was discovered. Furthermore, similar estimates for the more recent period, 1988 through 1996 revealed increased price sensitivity for the nation as a whole, at .60 1.64 and 3.12 for the one-year, three-year and six year cumulative elasticities, respectively. These results should be regarded with some caution as they suggest a dramatic increase that may be particular to the period of privatization and may not reflect a long term equilibrium.

National elasticity estimates for the period 1988 through 1996 were derived from a sample of eight years which is limited in terms of the degrees of freedom available. A similar model was estimated for Veracruz using mill level cross sectional time series data for the same eight year period. The elasticities estimated with that date were .104 .452 and .879 for the one year, three-year and six year elasticities, respectively. These estimates are not only larger than those estimated by Borrell for the earlier period, but it must be remembered that they lack the acreage component of elasticity (assumed positive) which is included in Borrell's version. Together these results suggest an increase in price sensitivity in the Mexican sugar industry, especially in the post privatization period.

Price-maker Model

Having statistically established the increased price sensitivity of supply, questions arise regarding the newly liberalized price of sugar in Mexico (Chapter 6). Aside from the

fact that sugar [illegible] at market pr[illegible] in the context of NAFTA to understand [illegible] necessary to which the Mexican domestic sugar price would have to comply in order to continue achieving net surplus producer status.

An assumption used in the model is that the industry can act as a price maker though it cannot directly influence supply. In this case one conclusion is that as long as the marginal revenue to the industry is greater than the world price, it will be beneficial to producers to sell all production in the domestic market. If the marginal revenue from domestic sales is less than the world price, then producers will be better off exporting that ton.

The optimal domestic price in this model was shown to be the price on the domestic demand curve corresponding to the quantity corresponding to the point on the marginal revenue curve where it intersects the world price. Adding the NAFTA scenario into the model suggests that a different domestic price might be ideal when the possibility of exporting to the United States is included. If domestic sugar demand is elastic and HFCS demand decreases proportionally more as a result of a decrease in sugar prices, then it will be beneficial to producers to decrease the domestic price from the optimal price described above in order to gain access to the U.S. market. Conversely, if sugar demand in Mexico is inelastic and the response of HFCS demand is less than proportional to a price-change for sugar, then it will be beneficial to producers to raise prices in order to access the U.S. market.

Another conclusion derived from the model is that if the supply curve were to continue to shift outward (to the right), the industry could continue to increase output and export to the world market at a favorable price, assuming the conditions above are met.

Further Research

Several important topics were not covered in this study and these be a [illegible] as they may be pivotal in determining the future direction of the industry The price maker model developed shows that sugar demand will play a key role in determining whether Mexico can be a net exporter of sugar A further study of sugar demand, estimates of the marginal revenue curve facing the industry and the cross price effects of sugar price on HFCS demand are necessary ingredients for additional empirical study of the Mexican sugar industry

A further study of the possibilities for land concentration in the industry would also be fascinating at this juncture To what extent economies of scale exist in Mexico is a real question given the history of the industry Also the trend in land rental is an interesting one which if economies of scale exist could be a solution involving both economic and social efficiency improvements

A technological study of the possibility of increasing the irrigation capacity for various regions of the country would also go far in explaining the potential of the industry This is one critical source of increasing yield that is occurring in the industry but was not covered in the study Often irrigation improvement involves a shared cost between the mills and growers that can be difficult to negotiate but in areas that have water available both mills and growers look forward to the day these improvements can occur

Finally the medium term policy context for the regional sweetener market is one that is potentially volatile The U S sugar policy plays the lead in the context of the region and yet it is an area of agricultural support that has managed to exist in an environment of

declining agricultural assistance. If the U.S. policy changes, the dynamics between all other sweetener producers will be involved. The U.S. embargo on Cuba is another important component of the regional sweetener situation which, if lifted, could radically change the region's trading patterns.

Mexico's sugar industry faces an interesting set of issues in terms of the domestic structural adjustment in the context of a free trade agreement and in the context of global competition. The decade 1998 through 2008 will be critical in terms of the sugarcane growers and mill owners. The developments in the industry will also be critical for producers in Florida, the Caribbean and other Latin American countries.

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Gretchen Greene was born and raised in the Pacific Northwest. She attended Wellesley College in Massachusetts and attained the degree of Bachelor of Arts in 1982. Her major field of study was religion studies. She then attended the University of Washington for three years in preparation for a career as a mathematics teacher. She taught mathematics in 1987–89 in Botswana as a Peace Corps volunteer and then worked in community development for an additional year in Botswana.

Gretchen entered the University of Florida's doctoral program in the Food and Resource Economics Department in 1991. Her interests include economics of natural resources, international trade, gender issues in economics and economic development.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality as a dissertation for the degree of Doctor of Philosophy

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